An Exploration of the Implicit Food Attitudes of People with Type-1 Diabetes using Reaction-time and Electrophysiological Measures

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Thesis Overview

This thesis comprises of a research (volume I) and a clinical (volume II) volume. The research volume includes a literature review and an empirical paper focussing on the evaluation of implicit food attitudes. Whereas the clinical volume includes five pieces of clinical work completed during the 3-year Doctorate in Clinical Psychology course.

Volume I.

Literature Review. The literature review begins by outlining theories of food attitudes emphasising the importance of implicit attitudes for learning about eating behaviours. Explicit attitudes are views that people are consciously aware of and implicit attitudes are more automatic views that people hold, which are based on more immediate reactions. Implicit attitudes can be assessed in a number of ways and this review focuses on the affective priming paradigm which is a computer based task using sets of prime and target stimuli. The technical aspects of this method of assessment are discussed with reference to the similarities and differences found across studies.

The use of the affective priming paradigm (APP) during food attitude studies has demonstrated mixed results, which are possibly due to the differences in how the APP has been used by different researchers. Specifically, studies have differed on a range of aspects including the type of primes and targets used (words, pictures, flavours and smells), the category that the primes were based on (palatability, fat content, pleasantness), the duration of time that a prime stimulus was shown to a participant before a target was presented, the people recruited to APP food attitude studies, the number of trials included in the study, and the way in which the information collected by the APP (reaction times and percentage of errors) has been analysed.

The APP was able to identify implicit attitudes that were based on pleasantness or palatability of the food prime, but attitudes based on the fat content of food such as high-fat and low-fat foods were not found. This may be because of a wide range of individual differences in food preferences where a person may enjoy high-fat sweet foods such as chocolate cake but not enjoy cheese cake. It is also possible that the people included in these studies did not have strong preferences towards foods and this may have also influenced the results. In addition, it was found that there were a number of potentially confounding variables that could have influenced the results, such as whether the participant had any allergies or excluded any foods for cultural or religious reasons, also when the participant last ate or drank and current level or hunger. These variables were not assessed for participants in all except two studies.

<u>Empirical Research.</u> The empirical paper used the APP to assess food attitudes of people with type-1 diabetes mellitus (T1DM). It was hypothesised that this sub-group of people would have strong food attitudes due to the focus on food that is associated with their illness. In addition, mixed results have been found in studies assessing implicit food attitudes and as such a measure of brain activity was used alongside the APP. Measuring brain activity using electroencephalogram (EEG) has been shown to identify implicit attitudes by analysing activity through time-locked event-related potentials (ERP's).

The results of the empirical study found that people with T1DM had similar implicit and explicit attitudes as non diabetic controls towards high-fat sweet (chocolate cake, ice cream), high-fat savoury (hamburger, chips) and low-fat foods (cucumber, strawberries). Both groups had positive attitudes towards all three food-types with no significantly different preferences found.

A group difference was observed in the EEG data for the N200 ERP which is a measure of response conflict and was found amongst the T1DM group and not the non diabetic group. This difference was found to be independent of food attitudes because it was identified for both food and non food pictures. As such, this finding was not explored further during this study and it is recommended that this finding becomes a focus of future research.

Volume II.

Volume II is a record of five clinical practice reports completed during the 3-year training programme.

Clinical Practice Report 1. Models Assignment. This report outlines the case of Oliver who is a 17-year old adolescent with Down's syndrome and a learning disability. He was referred to Psychology for support with a hospital phobia. The report outlines the assessment process and then provides two formulations of the presenting difficulties. These are from a behavioural and a systemic perspective. The report discusses the benefits of the two models.

Clinical Practice Report 2. Service Evaluation. A learning disability service was evaluated on the levels of activity that their service users (all adults) engaged in and this was found to be below the recommended guidelines of 3 x 30minutes per week. The perceived barriers to physical activity were obtained via interview from staff members working closely with the service users. Thematic analysis was performed on the interview transcripts and found three levels of barrier; individual, staff, service. Strategies were suggested to overcome the barriers.

Clinical Practice Report 3. Case Study. This report outlines the case of a 6-year old boy who was referred to psychology for behavioural difficulties and sleep problems. The assessment, formulation, intervention and evaluation are presented from the Solihull Approach framework. The intervention focussed on assisting parents to set consistent boundaries around a bed-time routine. Personal reflections on the process are provided.

Clinical Practice Report 4. Single Case Experimental Design. This report outlines the case of Mr Cotton, an 85-year-old gentleman experiencing symptoms of depression following the loss of his wife 18-months previously. An AB design was employed to evaluate the effectiveness of a cognitive-behavioural intervention. The case design was discussed, alongside generating small and large N research.

Clinical Practice Report 5. E-mail counselling for Depression. A PowerPoint presentation was delivered to members of my cohort detailing a piece of e-mail counselling that I had completed. Jennifer was an international student who was suffering depression impacted by loneliness and separation from her family who lived in China. The e-mail counselling process was discussed including the skills used with Jennifer and how this differed from traditional face-to-face counselling.

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Volume I: Research Volume

Volume II: Clinical Volume

A Review of the Literature on Affective Priming and Implicit Food Attitudes

Abstract

Implicit attitudes are assumed to be more resilient to demand effects than explicit attitudes and there are a number of methods that researchers have used to investigate them. The affective priming paradigm is one such method that has been used in the food attitude literature and this current paper reviews nine empirical studies that have used this approach. The rationale for the affective priming paradigm is presented and the wide variety of methodological differences between the papers are discussed. The differences provide an explanation for why the results and conclusions drawn from the studies are at times very different. The paper concludes that the affective priming paradigm is not an effective method for assessing food attitudes on dimensions of fat content but it is effective for assessing food palatability, particularly when the explicit attitude towards palatability is predetermined.

Introduction

Poor physical health and obesity are common consequences to an unhealthy diet (Roefs & Jansen, 2002) and the social influences of a desire towards low weight and a healthy diet may have a negative impact on the way that explicit attitudes towards food types are collected due to the effect of social desirability (Roefs & Jansen, 2002). Explicit attitudes are conscious views that a person holds and is aware of having whereas implicit attitudes are thought to be outside of conscious awareness (Wittenbrink, 2007) and are thought to influence behaviour in different ways (Perugini, 2005). Theories of implicit and explicit attitude models on behaviour were reviewed by Perugini (2005) who described three theoretical frameworks; dual, additive and interactive.

The model of dual attitudes (Wilson, Lindsey, & Schooler, 2000) suggests that people have both implicit and explicit attitudes towards the same object, which independently coexist. There are four versions of this model describing the association between awareness of the implicit attitude and motivation or cognitive effort required for the explicit attitude to override it. These versions are repression, independent systems, motivated overriding and automatic overriding. The repression model suggests that people are unaware of their implicit attitude because awareness of it would be anxiety provoking. Thus, they repress the implicit attitude and express explicit attitudes. The independent systems model suggests that implicit and explicit attitudes are independent to one another. The implicit attitude is automatic and does not reach the individual's conscious awareness yet it influences implicit evaluations, whereas the explicit attitude towards the same object is conscious and influences explicit evaluations. There is more empirical evidence for motivated and automatic overriding models of dual attitudes (Wilson et al., 2000) where individuals are aware of their implicit attitudes, which may be unacceptable or unwanted. People are motivated to override these automatic responses with an explicit attitude that is more acceptable to them. In the model of automatic overriding the individual is not aware of their implicit attitude and the explicit attitude overrides the implicit one without conscious effort or motivation. This model corresponds to a double dissociation framework where implicit attitudes predict implicit behaviours and explicit attitudes predict explicit behaviours (Perugini, 2005).

An additive framework suggests a single system with a single attitude (Perugini, 2005) and infers that the implicit and explicit evaluations are of the same attitude and jointly contribute to the prediction of behaviour.

A final model suggests that implicit and explicit attitudes contribute to an interactive framework where behaviour is influenced by both concepts (Strack & Deutsch, 2004). The implicit and explicit attitudes activate the same behavioural outcome using different operations. When they are congruent the behaviour occurs more naturally and with a strong influence. When they are incongruent the decision making may be more difficult and the behaviour occurs less fluently (Perugini, 2005).

Explicit attitudes can be assessed using self-report measures or during interviews where people are asked for explicit opinions of a given object or topic. These assessments do not always reflect the behaviours of the person, for example, obese people explicitly report a preference for low-fat foods over high-fat foods (Roefs, Herman, MacLeod, Smulders & Jansen, 2005a) yet they appear to consume more calorific food products, hence the obesity. This has led researchers to hypothesise that assessing implicit attitudes will provide more information about food attitudes. There are a number of methods for assessing implicit attitudes including the Affective Priming Paradigm (APP; Fazio, Sanbonmatsu, Powell & Kardes, 1986) the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998), the Go-No-Go task (GNAT; Nosek & Banaji, 2001), and more recently the Extrinsic Affective Simon Task (EAST; De Houwer, 2003).

The two most commonly used implicit methods for assessing food attitudes are the IAT and the APP. The IAT is a computer based assessment where participants are asked to respond to words or pictures from a concept dimension such as high-fat or low-fat and an attribute dimension such as positive or negative (Roefs & Jansen, 2002). Stimuli are presented on different trials and participants are instructed to respond to different combinations of concept and attribute pairings using different key assignments. For example, in the first step of a study by Roefs and Jansen (2002) participants were asked to respond to high-fat stimuli using the left key and to low-fat stimuli using the right key, in the second step they responded to positive stimuli using the left key and negative stimuli using the right key. In the third step participants responded to alternating concept and attribute pairings with high-fat and positive stimuli being assigned to the left key and low-fat and negative stimuli assigned to the right key. In the fourth step this was reversed and the key assignments were counterbalanced over participants (Roefs & Jansen, 2002). In this study the focus was on the fat content of the food stimuli and participants were asked to categorise the stimuli as high- or low-fat.

The IAT has been found to measure attitudes towards the global concept dimension of the category (i.e. high-fat food) rather than the attitude towards the individual concept presented (Roefs & Jansen, 2002). In addition, it has been observed that the IAT is influenced by social and cultural attitudes rather than the specific attitudes of the individual towards the concept that is presented (Wittenbrink, 2007). This suggests that to learn about an individual's attitude towards specific foods an alternative implicit measure may be more effective such as the APP.

The affective priming paradigm is a computer-based task which relies on reaction times to identify automatic attitudes (Fazio et al., 1986). During the priming paradigm, participants are shown two sets of stimuli, a prime and a target. The prime is shown for a short time (around 200ms) and the target is usually shown until the participant responds to it. Participants are asked to make a forced decision about the target (i.e. it is positive or negative?). The time it takes the participant to respond to the target is recorded and forms the basis of the analysis. If a prime and a target are congruent then it is expected that the reaction time will be shorter than if the prime and target are incongruent (Wittenbrink, 2007).

This method has been used successfully to investigate implicit attitudes in areas of alcohol (Ostafin, Palfai & Wechsler, 2003), smoking (Swanson, Swanson & Greenwald, 2001) and race (Dovidio, Kwakami, Johnson, Johnson & Howard, 1997) and led to a more complete understanding of the attitudes towards these social or health-related behaviours. Another area where it is important to assess both implicit and explicit attitudes is food choice and eating behaviour (Lamote, Hermans, Baeyens & Eelen, 2004). As such, this paper aims to review the contribution made by the APP method towards exploring food attitudes. The review will focus on empirical research studies and will explore the following methodological factors;

- Participants studied
- Materials used

- The procedural process
- Design and Analysis of the data
- Results found

The initial sections of this review (participants, materials, procedure, design & analysis) will present the technical set-up of the APP studies including how they have been designed to address the hypotheses posed by researchers. Differences in methodology can be used to explain differences in the results between the studies, which is why this initial section is important. The final sections (results) will draw together the conceptual findings that have been observed using this method of assessment and a discussion will be presented drawing all the above into consideration to explain how the APP has contributed to an understanding of food attitudes.

Search Strategy

The PsycINFO, Web of Science and PubMed electronic databases were searched to find relevant empirical papers. The Keyword search terms were; affective, prim$ (for prime/ priming), implicit attitude$ (for attitude/ attitudes), attitude$, combined using the 'And' function with food, eat$ (for eating, eat), food choice, food preference, diet$ (for diet, dieting, diets, dieter), consum$ (for consuming, consumer, consumed, consume). The terms were searched for in the title, abstract, heading word, table of contents or as a key concept. The first paper was written in 2004 and as such the date parameters were 2004 to present day (February week 4 2011). The inclusion criteria were that the paper described an empirical study using the affective priming paradigm to elicit food attitudes. Papers were excluded if they were theoretical (non empirical) or if the participants recruited to the study were children. The search returned 11 empirical papers. Each paper was read chronologically for evidence of additional papers that might not have been picked up by the electronic database search. The 'cited by' electronic function was also used to identify any additional papers. There were no papers to add and during this process two papers were excluded because they were not empirical studies. The remaining nine papers describe 14 separate empirical studies that form the content of this review on implicit food attitudes using affective priming methods.

Participants

This section will describe the different populations that have been studied followed by a closing statement about the generalisability of the findings.

A total of 830 participants have taken part in an APP study on food attitudes since the first study in 2004. Of these, the majority of participants were female (724; 87.23%) and 10 of 14 studies recruited from University populations (both students and staff). The median average of the mean age range was 21.94 years with a range of means from 19.5 to 41.8 years. The majority of the studies have been conducted with Dutch participants (12 of 14). The remaining two studies recruited from hospitals and through newspaper and magazine advertising.

Age & Gender. Gender has not been a focus of interest by the studies reviewed here, it has not been used as a grouping variable and no gender differences have been reported suggesting that gender differences in implicit food attitudes are yet to be explored. In addition there were no age related differences reported in any of the studies included in this review.

Nationality. There were two studies (Czyzewska & Graham, 2008; Roefs et al., 2005a) that recruited from an American population totalling 152 participants (18.31% of the total population sampled) the remaining studies recruited Dutch participants (678; 81.69% of the total sample). This bias towards Dutch recruitment may limit generalisability to this sub-group.

Body Mass Index (BMI). When thinking about attitudes towards food and how an understanding of this can be used to inform the promotion of healthy behaviours, the BMI of participants becomes an important factor. One study found that obese women have significantly more positive implicit attitudes to high-calorie savoury food (such as pizza and fried chicken) than healthy-weight and overweight women (Czyzewska & Graham, 2008). Another study found no effect of BMI on implicit food attitudes (Roefs et al., 2006).

Furthermore, one study examined the implicit attitudes of women with eating disorders and found no affective priming effect for the palatability of food, whereas non-eating disordered women in the same study did show a priming effect to the palatability of food (Roefs et al., 2005b). This is possibly due to the pathology of eating disorders and the hypothesis that the palatability of food is no longer a consideration for people with an eating disorder, which makes the restriction of food easier for them (Roefs et al., 2005b).

Additional food related participant variables. There are a number of confounding variables that may influence the results of a study on food attitude and these can be controlled for in the study design. These include time of testing, time since last meal, current hunger level and restriction of any food-types (i.e. vegetarian or for cultural or religious or health/allergy reasons). Of the studies reviewed only one reported consistently assessing participants at the same time of day and this was between 1.30pm to 2.30pm (Roefs et al., 2006).

Furthermore, only two studies controlled for the time since the participant last ate (Roefs et al., 2006; Veldhuizen, Oosterhoff & Kroeze, 2010). Roefs et al. (2006) were interested in the influence of induced craving and they instructed participants to refrain from eating for 2-hours prior to the assessment. Craving scores were obtained using a 100mm visual analogue scale (VAS) although the question that was asked to measure craving was not made explicit in the procedure and this makes it difficult to fully understand exactly what has been measured.

Veldhuizen et al. (2010) used flavour primes (cold coffee and strawberry lemonade) and instructed participants to abstain from smoking, eating and drinking for an hour prior to the assessment and not to drink coffee for the day. Furthermore, they screened their participants for chemosensory deficits using a questionnaire that asked about tasting and smelling abilities to control for any deficits that might confound the results (Veldhuizen et al., 2010). These steps ensure that simple individual differences are not the root cause of differences found using the APP.

Summary. Studies investigating implicit food attitudes using the APP have recruited predominantly Dutch, young adult, female University students. As such, generalisations drawn from the findings of these studies should be restricted to these populations. Future research should be broadened to study more varied populations, and would benefit from applying inclusion and exclusion criteria that may possibly have a confounding impact on food attitudes.

Materials

This section discusses the materials used in the APP to increase our understanding of implicit food attitudes.

Stimulus Selection and Presentation

Different types of stimuli that have been selected for use in these studies and the presentation methods such as words, pictures and flavours will be presented.

Primes. Primes have included pictures, words, odours and flavours (Tables 1 and 2). In their initial study on implicit food attitudes Lamote et al. (2004) used 116 photographs of food items rated individually by participants on a 21-point scale from very unpleasant (-100) to very pleasant (+100). Each participant thus selected their own primes. In their first study they used the four most positively and four most negatively rated images and in their second study the primes were selected from the 25th percentile (moderately negative) and 75th percentile (moderately positive) of the individual ratings. Lamote et al. (2004) found that both strongly valenced and moderately valenced primes were effective in producing the affective priming effect for food items. Additional picture primes have included high-calorie sweet, non-sweet and low-calorie pictures (Czyzewska & Graham, 2008) and high-fat palatable, unpalatable and neutral food pictures (Papies, Stroebe & Aarts, 2009), with palatability assessed in a pilot study of items rated on a 5-point scale (Papies et al., 2009).

Table 1. Picture Prime Stimuli

High Calorie Non Sweet	High Calorie Sweet	High Fat Palatable	Low Calorie Foods	Unpalatable Foods	Neutral Foods
Pizza	Ice cream	*Pizza*	Salad	Cooked cabbage	Lettuce
Fried chicken meal	*Chocolate cake*	*Cake*	Veggie wrap	Blood sausage	Soup

Italicised primes appear in more than one column

Table 2. Word Prime Stimuli

High Fat Foods	High Fat Palatable	High Fat Unpalatable	Low Fat foods	Low Fat Palatable	Low Fat Unpalatable
Bacon	*Chocolate*	*Herring*	Apple	*Strawberries*	Brussels sprouts
Cake	*Chips*	*Slice of bacon*	Banana	Grapes	
Cheese	*Fries*	Pate	Bread	*Melon*	Chicory
Chips	Croissant	Butter	Broccoli	Chicken	Sauerkraut
Chocolate	Pizza	Peanut butter	Cabbage	Popcorn	Endive
Coconut	Ice cream	*Walnut*	Fruit	Liquorice	*Radish*
Cookie			Juice		Cod
Donut			*Melon*		
Fries			*Radish*		
Fudge			Popcorn		
Hamburger			Rice		
Herring			Spinach		
Nachos			*Strawberry*		
Pancake			Tomato		
Peanuts			Turkey		
Walnuts			Yogurt		

Italicised primes appear in more than one column

Word primes are presented in Table 2 and have included high and low-fat food words (Roefs et al., 2005a), and high and low-fat palatable and unpalatable food words (Roefs et al., 2005b; Roefs et al., 2006). The palatability of the food primes were generated from a pilot study where female University students ordered lists of high- and low-fat foods in terms of palatability (Roefs et al., 2005b; Roefs et al., 2006).

Hermans, Baeyens, Lamote, Spruyt and Eelen, (2005) used odour primes in their study investigating the use of the APP for measuring recently acquired food attitudes. The odour primes were positive (raspberry), highly negative (civet) and neutral (odourless). Each odour was paired with a photograph of a pack of yoghurts to see how different odours influenced food attitudes.

Verhulst, Hermans, Baeyens, Spruyt and Eelen, (2006) and Kerkhof, Vansteenwegen, Baeyens, and Hermans, (2009) used four cookies as primes that were flavoured with positive (honey or hazelnut), or negative (vegetable bouillon or salt and liquid cinnamon/ polysorbate 20) flavours. Each cookie was baked in a different shape and colour and the presentation of these were counterbalanced across participants. Veldhuizen, Oosterfoff and Kroeze (2010) also used positive (strawberry lemonade) and negative (cold coffee) flavour stimuli to prime their participants. The flavours were administered directly into the mouth of the participant using a gravitational flow system (Veldhuizen et al., 2010).

Targets. Targets have included positive and negative non-food words (Hermans et al., 2005; Lamote et al., 2004; Roefs et al., 2005a; Roefs et al., 2005b; Veldhuizen et al., 2010); positive and negative food words (Veldhuizen et al., 2010) and positive and negative colour pictures (Verhulst et al., 2006).

Positive and negatively valenced targets are central to the affective priming effect (Fazio et al., 1986) and the strength of word valence is also important. Some positive (or negative) words are more positive (or negative) than others, for example love and triumph were rated as more positive than sentiment and famous (Bradley & Lang, 1994). Bellezza, Greenwald and Banaji, (1986), Hermans and De Houwer, (1994), and Bradley and Lang (1999) all provide normative data on the valance of every-day words, which have been used in APP studies.

Roefs et al. (2005a) selected their targets from a list of words provided by Bellezza, Greenwald and Banaji, (1986) which outlines the mean and standard deviation of 399 words for good/bad; pleasant/unpleasant and emotional/unemotional dimensions. The normative data of every-day Dutch words (Hermans & De Houwer, 1994) was used by six studies for their target selection (Hermans et al., 2005; Lamote et al., 2004; Roefs, et al., 2005b; Roefs, et al. 2006; Kerkhof et al., 2009; Veldhuizen et al., 2010) whereas Czyzewska and Graham, (2008) used Bradley and Lang's (1999) Affective Norms for English Words (ANEW) database of 1,034 words rated on valence, arousal and dominance to select their targets. Finally, Papies et al. (2009) and Verhulst et al. (2006) asked participants in their studies to rate potential targets from a pre-defined selection, which generated individually rated targets. All of the studies report statistically significant differences between the positive and negative word targets ensuring that they are accessing two separate emotional systems; one positive and one negative (Wittenbrink, 2007).

Validated Questionnaire Measures. The Restraint scale (Herman & Polivy, 1980) has been most commonly used during these studies and is a 10-item self-report questionnaire assessing dieting behaviour across two subscales; concern for dieting and weight fluctuation (van Strien, Herman, Engels, Larsen & van Leeuwe, 2007). Unrestrained eaters are characterised by scores of less than 14 and restrained eaters have scores greater than 15. This questionnaire has been used to classify participants into groups in seven of the studies reviewed in this paper with full scale scores presented in Table 3. Papies et al. (2009)

grouped participants in terms of restrained and unrestrained eaters using the Concern for Dieting subscale of the Restraint Scale. In their first study they report a mean score of 10.85 (SD = 4.9) for all participants, reporting that the restrained group have scores one standard deviation above the scale mean, and the unrestrained group have scores one standard deviation below the scale mean.

Table 3. Reported Restraint Scale Mean Scores and Standard Deviations

Author	Restrained (15>)	Unrestrained (15<)
Roefs et al. (2005a)	20.0 (SD 2.0)	8.1 (SD 3.3)
Roefs et al. (2005b)	17.4 (SD 5.1)	7.3 (SD 2.3)
Roefs et al. (2005b)	19.3 (SD 3.8)	8.4 (SD 3.2)
Roefs et al. (2006)	19.3 (SD 5.3)	8.5 (SD 2.3)
Roefs et al. (2006)	19.1 (SD 4.0)	8.8 (SD 3.2)

Restrained Eaters. Restrained eaters show periods of restrained eating interspersed with periods of overeating and it is thought that this behaviour increases the attractiveness of high-fat foods that are usually self-forbidden (Roefs et al., 2005). Three studies have found no group differences in implicit food attitudes between restrained and unrestrained eaters (Roefs et al., 2005a; Roefs et al., 2005b; Roefs et al., 2006).

Using a regression model analysis Papies et al. (2009a) were the only study who found significant differences between restraint scores and food-type (palatable, neutral, unpalatable), although this difference was only present amongst unrestrained eaters who evaluated palatable foods more positively than neutral or unpalatable foods. Response latency analysis found no group differences in the reaction time on food-trials, which is consistent with the studies discussed above.

The Dutch Eating Behaviour Questionnaire (DEBQ; Van Strien, Frijters, Bergers & Defares, 1986) and the Disinhibited Eating Scale (DIS; Overduin & Jansen, 1996) were used in one study, which resulted in no group differences and had no impact on the results when entered as covariates in the analysis (Czyzewska & Graham, 2008).

Explicit Evaluation Measures. Of the 14 studies, ten have collected explicit attitudes towards the food prime either before (Lamote et al., 2004; Roefs et al., 2006; Verhulst et al., 2006), after (Roefs et al., 2005a; Czyzewska & Graham, 2008; Papies et al., 2009) or before and after (Hermans et al., 2005; Kerkhof et al., 2009; Veldhuizen et al., 2010) the APP. Table 4 outlines the ways in which studies have obtained explicit information. Obtaining both implicit and explicit food attitudes can add evidence to existing attitude theories (Perugini, 2005).

Table 4. Explicit Evaluation Procedures on Prime Stimuli

Authors	Explicit Evaluation	Scale	Anchors
Lamote et al., 2004a	Pleasantness	21-point	-100 (very unpleasant)

& 2004b			+100 (very pleasant)
Verhulst et al., 2006	Pleasantness	21-point	-100 (very unpleasant) +100 (very pleasant)
Roefs et al., 2005a	Likeability	5-point	1 (dislike a lot) 5 (like a lot)
	Tastiness	Rank order	Most tasty to least tasty
Czyzewska & Graham, 2008	Pleasantness	7-point	1 to 7
Papies et al., 2009	How positive/ negative are the positive/ negative aspects of the food	9-point	Not reported
Hermans et al., 2005	Attractiveness/ Pleasantness	21-point	-100 (little attractive/ not at all pleasant) +100 (very attractive/ pleasant)
Kerkhof et al., 2009	Pleasantness	21-point	-100 (very unpleasant) +100 (very pleasant)
Veldhuizen et al., 2010	Intensity/ Pleasantness	Visual analogue scale	0 (very weak/unpleasant) 100 (very strong/pleasant)
Roefs et al., 2006	Healthiness	7-point	1 (very unhealthy)

7 (very healthy)

Summary. This section has described the target and prime stimuli that have been used in studies investigating food attitudes with the APP and why they are important when learning more fully about food attitudes. Primes have been categorised into food types or palatable foods to address specific hypotheses and targets have primarily been positive or negative non-food words. The combination of using questionnaires to identify separate subgroups of people such as restrained eaters, along with assessing both implicit and explicit attitudes, will add more information about differences between these groups on their food attitudes.

Procedure

The technical set-up of the APP and differences in methodology will be discussed including the presentation of primes and targets and the number of trials included in each study.

A range of software programmes including Affect 1.0, 3.0 or 4.0 (Hermans et al., 2005; Lamote et al., 2004; Verhulst et al., 2006; Kerkhof et al., 2009); Experimental Run Time System (ERTS; Roefs et al., 2005a; Roefs et al., 2006); SuperLab V.2.0 (Czyzewska & Graham, 2008); and E-Prime (Veldhuizen et al., 2010) have been used to set-up APP studies. The software enables the researcher to create a programme where prime and target stimuli can be entered. Colours, font sizes, duration of presentation of stimuli, order of stimuli, number of trials, pre-experimental instructions and information to be recorded (i.e. reaction times) can all be specified, which provides a wide range of possible procedures.

Researchers are interested in how the information presented is processed and this can be associated with the number of trials completed and the exposure times to both the prime and target. Table 5 shows the exposure times to different components of the APP.

Veldhuizen et al. (2010) used a method where the prime was a flavour (either cold coffee or strawberry lemonade) squirted into the mouth of the participant. The cognitive evaluation of taste takes more than 600ms to be processed, which explains why the exposure times are much longer than the exposure times for word or picture variants (Veldhuizen et al., 2010).

Table 5. Priming Procedure

Authors	Presentation of the prime	Inter-Stimulus Interval	Stimulus Onset Asynchrony (SOA)	Inter-trial Interval
Lamote et al. (2004a)	250ms	50ms	300ms	3000ms
Lamote et al. (2004b)	250ms	50ms	300ms	3000ms
Roefs, et al. (2005a)	200ms	-50ms	150ms	3000ms
Roefs, et al. (2005b)	150ms	0ms	150ms	2500ms
Roefs, et al. (2005b)	150ms	0ms	150ms	2500ms
Roefs et al. (2006)	150ms	0ms	150ms	2500ms
Roefs et al. (2006)	150ms	0ms	150ms	2500ms
Verhulst et al. (2006)	200ms	50ms	250ms	1000ms (mean)
Czyzewska & Graham (2008)	200ms	50ms	250ms	Not reported

Papies et al. (2009a)	250ms	50ms	300ms	1500ms
Papies et al. (2009b)	250ms	50ms	300ms	1500ms
Kerkhof et al. (2009)	200ms	50ms	250ms	1000ms (mean)
Veldhuizen et al. (2010)	380ms	190ms	570ms	58 seconds

Exposure of prime stimuli has occurred between 150-250ms followed in most studies by an inter-stimulus interval of 50ms generating stimulus onset asynchronies (SOA), between 250ms and 300ms (Czyzewska & Graham, 2008; Kerkhof et al., 2009; Lamote et al., 2004; Papies et al., 2009; Verhulst et al., 2006).The priming effect is present when the SOA is short with an optimal exposure of 150ms (Herman et al., 2001) to ensure fairly automatic processing. If the SOA becomes longer, the participant may have time to make a more explicit decision about, or acknowledgement of, the prime (Roefs et al., 2005) and if it is shorter, the participant may not have time to attend to it. Some studies have programmed their studies to ensure a SOA of 150ms for optimal exposure of the prime in relation to the presentation of the target (Roefs et al., 2005a; Roefs et al., 2005b; and Roefs et al., 2006). In one study this involved overlapping the presentation of the prime and the target for 50ms (Roefs et al., 2005a). This overlap may have impacted on the APP results in a negative way and the researchers altered their procedure for subsequent studies to remove the overlap by presenting the prime for 150ms and having no inter-stimulus interval (Roefs et al., 2005b).

Trials. The number of experimental trials presented across the studies has ranged from 56 to 194 (see Table 6). Most studies report a set of practise trials which enable the participant to become familiar with the process of a novel situation. Czyzewska & Graham (2008) report that participants were given practice trials but they did not report how many. Papies et al. (2009) report 10 practice trials in their first study and through personal communication they report running no practice trials for the second study (E. Papies, personal communication, April 26, 2011). During the practise trials many of the studies presented stimuli that were not used in subsequent experimental trials (Roefs et al., 2005a; Roefs et al., 2006; Papies et al., 2009). Some studies gave feedback during practise to ensure the participant understood what was being asked of them (Papies et al., 2009). This can reduce any initial anxiety about performing such a task under experimental conditions and can reduce the likelihood of errors occurring.

Practise trial effects are observed in the results of studies that report block effects in their analyses. Significantly faster responses were reported in the second block of experimental trials when compared to the first in two studies by Lamote et al. (2004) and one by Kerkhof et al. (2009) who had 10 and 12 practise trials respectively. In contrast, Verhulst et al. (2006) used 24 practise trials and reported significantly faster response times in the first and second blocks (both M=591ms) as compared to the third (M=601ms). The extended practise period of Verhulst et al. (2006) may have prepared the participant for the experimental trials, which can explain why the means are the same for both blocks (Verhulst et al., 2006). The slower response times in the third block may reflect fatigue.

Summary. This section has outlined the technical process of using the APP to identify implicit attitudes towards food and has highlighted a number of differences in the procedures used by different researchers. These differences can be used to explain some of the reasons why the findings from these food attitude studies have not been consistent and this is discussed in the results section.

Table 6. Number of trials presented to participants in each study

Authors	Practise trials	Experimental trials
Lamote et al. (2004a)	10	2 x 80 = 160
Lamote et al. (2004b)	10	2 x 80 = 160
Roefs, et al. (2005a)	16	3 x 64 = 194
Roefs, et al. (2005b)	16	3 x 48 = 144
Roefs, et al. (2005b)	16	3 x 48 = 144
Roefs et al. (2006)	16	3 x 48 = 144
Roefs et al. (2006)	16	3 x 48 = 144
Verhulst et al. (2006)	24	3 x 48 = 144
Czyzewska & Graham (2008)	n/r	96
Papies et al. (2009a)	10	60
Papies et al. (2009b)	0	100
Kerkhof et al. (2009)	12	2 x 40 = 80
Veldhuizen et al. (2010)	16	56

Design & Analysis

This section will outline the ways in which researchers have approached the analysis of the data generated by the APP including preliminary analyses and methods used to generate a score for implicit attitudes.

The main components of APP data preparations prior to performing any analysis are outlined in Table 7. A number of authors have limited the response times to those occurring between a predefined cut off time (see Table 7). Responses occurring before 200ms after target onset are thought to occur too quickly for the priming effect to have taken place (Roefs et al., 2005a) and responses that occur after 2000ms are thought to be influenced by explicit information and again are not measuring the implicit attitude that the priming paradigm is aiming to assess (Roefs et al., 2005a). Authors adopting this procedure have reported the percentage of trials discarded due to response time (see Table 7). A number of authors have also performed analyses on correct responses only because incorrect responses can skew the results (Wittenbrink, 2007). These studies have reported the percentage of incorrect responses that have been discarded following this preliminary procedure (see Table 7).

Table 7. Results of preliminary data analysis during each study

Authors	Fast response cut off	Slow response cut off	Percentage of trials discarded due to response time	Percentage of error responses discarded
Lamote et al. (2004a)	250ms	1500ms	0.73%	3.18%
Lamote et al. (2004b)	250ms	1500ms	0.89%	3.47%

Roefs, et al. (2005a)	200ms	2000ms	0.19%	4.5%
Roefs, et al. (2005b)	200ms	2000ms	0.44%	3.8%
Roefs, et al. (2005b)	200ms	2000ms	0.45%	2.6%
Hermans et al. (2005)	250ms	1500ms	1.2%	5.8%
Roefs et al. (2006)	200ms	200ms	0.35%	5.1%
Roefs et al. (2006)	200ms	2000ms	0.56%	3.5%
Verhulst et al. (2006)	Reaction times deviating more than 2.5 standard deviations from the mean of each cell design		1.2%	0.03%
Czyzewska & Graham (2008)	Preliminary statistical procedures were not reported			
Papies et al. (2009a)	RT larger than 2SD from the trial mean were discarded		Not reported	Not reported
Papies et al. (2009b)	RT larger than 2SD from the trial mean were discarded		Not reported	Not reported
Kerkhof et al. (2009)	200ms	1500ms	0.88%	7.25%
Veldhuizen et al. (2010)	250ms	1500ms	0.36%	7.86%

The main outcome measure of the APP is response time and researchers have taken different steps towards making use of this dependent variable to obtain a measure of implicit attitude. Some studies have used the mean response time scores directly as a measure of implicit attitude where a faster response to prime and target trials that are congruent compared to incongruent trials reflect a positive implicit attitude (Lamote et al., 2004; Roefs et al., 2005a; Roefs et al., 2005b; Verhulst et al., 2006; Kerkhof et al., 2009). Analysis of data in this form has been described as a basic procedure by Wittenbrink (2007) who highlights that differences in response times may represent differences that occur independent to the prime and this is illustrated by studies that report faster responses to positive targets than negative targets regardless of the prime conditions (Lamote et al., 2004; Veldhuizen et al., 2010).

Alternative measures have used the response time data in specific formulae to generate different attitude index scales. A relative attitude index was implemented by Roefs et al. (2006) which used mean response times to high-fat (or palatable) primes in relation to low-fat (or unpalatable) primes. This relational method can conclude that attitudes towards one set of primes (i.e. high-fat foods) are more positive (or negative) in relation to attitudes towards another set of primes (i.e. low-fat foods). An implicit attitude index was used by Czyzewska and Graham, (2008) where median response times to primes paired with a positive target were subtracted from response times of primes paired with a negative target. The conclusions that can be drawn from these data are that positive values reflect positive implicit attitudes and negative values reflect negative implicit attitudes towards the prime. Finally, a positivity index was used by Papies et al. (2009) which was similar to Czyzewska and Graham (2008) but with mean response times rather than median response times. Although these formulas provide a more sophisticated analysis of the data, the different approaches make it difficult to draw direct comparisons of results across studies.

Summary. This section has described the preliminary analyses that researches have made to their data sets before running their analyses. Differences in these approaches make it difficult to draw direct comparisons between studies.

Results

This section will discuss the findings that have been reported using the APP and how they increase our understanding of attitudes towards foods and will be reported depending on the type of analysis performed on the data.

Evidence of a food priming effect

Reaction time analysis. Positive implicit attitudes towards moderate and strongly rated pleasant foods, and negative implicit attitude towards unpleasant foods were found for male and female university staff and students (Lamote et al., 2004; Verhulst et al., 2006; Kerkhof et al., 2009; Veldhuizen et al., 2010). Similarly, a positive implicit attitude for palatable foods and a negative implicit attitude for unpalatable foods were found for restrained and unrestrained eaters (Roefs et al., 2005a) and unrestrained healthy-weight women but not women with eating disorders (Roefs et al., 2005b). In fact no implicit food attitudes were found for women with clinically diagnosed eating disorders possibly because the palatability of food items and thus their positive valence is no longer a motivating factor for them (Roefs et al., 2005b).

Positivity index. Unrestrained eaters have been found to have positive implicit attitudes towards palatable foods compared to unpalatable foods or neutral foods, whereas restrained eaters were found to have no preference of palatability (Papies et al., 2009).

Attitudes towards different food types

Reaction Time Analysis. There were no differences in implicit attitudes to high and low-fat foods for restrained and unrestrained women (Roefs et al., 2005a) or for obese (restrained) and healthy-weight (unrestrained) women (Roefs et al., 2005b).

Implicit Attitude Index. Implicit attitudes based on fat content were only found when using high arousal and not low-arousal word targets in a study by Czyzewska and Graham (2008). Positive implicit attitudes were found towards high-calorie sweet foods whereas negative implicit attitudes were found for high-calorie non-sweet and low calorie foods (Czyzewska & Graham, 2008). Additional analyses revealed differences in implicit attitudes between healthy-weight, overweight and obese women with healthy-weight and overweight women showing positive implicit attitudes towards high-calorie sweet foods whereas obese women had negative implicit attitudes towards these foods. Conversely, healthy-weight and overweight women showed negative implicit attitudes towards high-calorie non-sweet foods whereas obese women had positive implicit attitudes towards these foods.

<u>*Study Specific Manipulations*</u>

Evaluative Conditioning. Verhulst et al. (2006) were interested in the ability of the APP to measure recently acquired food attitudes and they grouped participants into a sensory liking or an expected consequences condition. The sensory liking group experienced positive tasting cookies (flavoured with hazelnut or honey) and negative tasting cookies (flavoured with vegetable bouillon of salt and liquid cinnamon). These differed in colour and shape that were counterbalanced across participants. The expected consequences group were presented with photographs of the four types of cookies with positive or negative information about the cookie printed below the photograph. Results found that recently acquired food attitudes could be measured implicitly and this was true for both sensory liking and expected consequences conditions (Verhulst et al., 2006).

Information Engagement Conditioning. Roefs et al. (2006) were interested in the effects of palatability and healthiness. They assigned participants to either a restaurant condition (palatability) or a health condition (healthiness). The restaurant group were focused on the palatability of high-fat foods for a special dinner for a wedding and were presented with 14-sets of two menus to choose from, each with a high-fat food option. The health group were focussed on information about healthy eating habits. Participants were presented with 14-sets of two menus one a healthy menu and one an unhealthy (high-fat) menu and asked to rate which menu was healthier (Roefs et al., 2006). This manipulation affected the direction of the results of the APP where restaurant condition participants responded more favourably to high-fat foods over low-fat foods and health condition participants demonstrated the opposite result. Although these results were only marginally significant ($p=.06$) and there were no statistically significant group differences.

Food Craving. Food craving was induced in obese and healthy-weight women using chocolate, croissants and crisps (Roefs et al., 2006). Craving was hypothesised to focus the participant on the implicit evaluations of the palatability of food primes rather than healthiness. Food craving was assessed on a 100mm visual analogue scale and participants were asked to intensely smell and taste a little bit of the food that they liked best. The food remained at the computer during the APP and the experimenter remained in the room. The results did not have the expected effect of focussing evaluations on the palatability of the food and conversely implicit attitudes were more positive to low than high-fat foods.

Differences between implicit and explicit food attitudes

Explicit food attitudes have been assessed on dimensions of pleasantness/palatability (Lamote et al., 2004; Roefs et al., 2005a; Roefs et al., 2006; Verhulst et al., 2006; Czyzewska & Graham, 2008; Veldhuizen et al., 2010); flavour intensity (Veldhuizen et al., 2010); and healthiness (Roefs et al., 2006). When implicit and explicit attitudes are assessed together the findings are mixed.

Some studies have found matching implicit and explicit food attitudes on dimensions of pleasantness and palatability (Lamote et al., 2004; Verhulst et al., 2006; Roefs et al., 2005a; Roefs et al., 2006; Czyzewska & Graham, 2008). Veldhuizen et al. (2010) found that two flavour primes (strawberry lemonade and cold coffee) were explicitly rated as intensely as one another, where strawberry lemonade was as pleasant as cold coffee was unpleasant. A chi-squared analysis demonstrated statistical agreement by participants between the explicit and implicit attitudes towards the strawberry lemonade but not the coffee. This was the only study to perform statistical analyses on the relationship between implicit and explicit attitudes.

Differences in implicit and explicit attitudes have been found in the preference of high- and low-fat foods (Roefs et al., 2005a; Roefs et al., 2006; Czyzewska & Graham, 2008). Roefs et al. (2005a) found that participants had an explicit preference for low-fat foods over high-fat foods but that there were no significant differences in implicit attitudes towards these foods. Explicit attitudes are assessed directly with the participants' knowledge whereas the implicit attitudes are a more automatic process. When asked directly a person is motivated to provide an answer to how much they like something, however, when taking part in an implicit attitude assessment the instructions are to attend to the target word rather than the food prime. The primes used in this study were presented as words whereas pictures are thought to elicit stronger representations of the actual objects during APP studies (Czyzewska & Graham, 2008). As such the food words may not have elicited a strong enough representation of the prime object and this may explain why there were no differences in implicit attitudes towards high- and low-fat foods despite clear explicit differences.

Czyzewska and Graham (2008) found similarities and differences in attitudes towards high and low-fat foods. Matching attitudes include negative implicit and explicit attitudes towards low-fat foods for healthy-weight, overweight and obese women with no group differences. Healthy-weight and overweight women had similar implicit and explicit food attitudes towards all food-types which were positive towards high-calorie sweet foods and negative towards high-calorie non-sweet foods. These attitudes support additive and interactive frameworks (Perugini, 2005) that suggest implicit and explicit attitudes are measures of the same construct.

Differences however, were found in Czyzewska and Graham's (2008) study for obese women who had positive explicit and negative implicit attitudes towards high-calorie sweet foods. Furthermore, obese women had negative explicit attitudes and positive implicit attitudes to high-calorie non-sweet foods, which is the opposite result. These differences support the framework of dual attitudes (Perugini, 2005). It might be hypothesised that due to the nature of obesity these individuals consume more high than low-fat foods, and that they have a preference for these foods, which leads to their consumption. The repression model of dual attitudes would suggest that there is an anxiety about having a positive attitude towards high-calorie non-sweet foods that is repressed while expressing an explicit negative attitude (Wilson et al., 2000). An independent systems model would suggest that the individual is not aware of their implicit attitudes and might be surprised to be told that they have generated these outcomes (Wilson et al., 2000). The motivated overriding model would suggest that obese people are unaware on a conscious level of their positive implicit attitudes towards high-calorie non-sweet foods and subconsciously this is viewed by them as unacceptable or unwanted. This leads the individual to override the implicit attitude and report an explicit one which is more acceptable to them (Wilson et al., 2000).

One of the key components for understanding attitude models is how they influence behaviour and none of the studies discussed in this section have included a behavioural measure of food attitudes or preference. A major step forwards with this body of research would be to include behavioural measures of the attitudes that researchers are assessing both implicitly and explicitly.

Discussion

This review has outlined methodological components of the affective priming paradigm and its application to generate the priming effect for food attitudes. The priming effect is observed when congruent prime and target pairs result in shorter reaction times than incongruent pairs, which is consistent with both spreading activation and response conflict theories of cognitive processing (Wittenbrink, 2007).

In general, the priming effect was evidenced for moderate and strongly valenced food items on affective dimensions of palatability and pleasantness, but not for the dimension of fat content. Palatability and pleasantness are affective attitude dimensions where pre-determined knowledge, through pilot studies or individual ratings, were used to identify how pleasant or palatable the food primes were. This process has ensured that the prime is affectively valenced positively or negatively and the strength of the association when paired with an affectively valenced target (positive or negative word) generates the priming effect (Wittenbrink, 20007). Thus, positive primes elicit faster responses to positive targets and vice versa.

It is possible then, that fat content does not generate an affective response and so is not an effective prime for responses to positive or negative targets. High and low-fat foods might prime responses to targets that reflect concepts associated with these dimensions such as 'tasty' for high-fat foods, and 'slimming' for low-fat foods. When high- and low-fat foods were jointly categorised on dimensions of palatability and healthiness, a priming effect was observed (Roefs et al., 2006), which suggests that the affective dimension is crucial to ensuring that the prime generates the priming effect.

Studies assessing implicit attitudes on palatability and pleasantness have generally been aware of the participants explicit attitudes towards these primes prior to their inclusion in the APP (i.e. they are pleasant or unpleasant). In contrast, however, Czyzewska and Graham (2008) were not aware of the explicit attitudes of their participants towards high-fat sweet, non-sweet, and low-fat foods and they found a priming effect of fat content. They used an implicit attitude measure to analyse their results based on the relationship between the response time to the prime when paired with a negative and a positive target. This generated one score per food category rather than two as is found in the basic reaction time analyses. A positive attitude was observed if a positive score was obtained and a negative attitude was observed by a negative score (Czyzewska & Graham, 2008). This may explain why this research found a palatability effect of fat content where no other has and might lead to questions about what each method of data analysis is actually measuring.

Reaction time analysis may not take the interaction effects of the prime stimuli into account and may simply be a measure of the influence of the target (Wittenbrink, 2007). Main effects of target valence have been reported during some of the food attitude studies independently of prime stimuli (Lamote et al., 2004; Veldhuizen et al., 2010). Theoretically, the negativity bias as outlined in cognitive research paradigms suggests that people attend or respond to negative stimuli in their environments more quickly than positive stimuli, however results of these food attitude studies reported that positive targets were responded to more quickly than negative targets regardless of the prime (Lamote et al., 2004; Veldhuizen et al., 2010). This positivity bias may be due to the participants not viewing the food primes as particularly negative. A negativity bias then may be observed in studies with people who do have negative associations with foods such as those with food allergies, or maybe people with eating disorders. In the one study that worked with people with eating disorders however, no priming effects were found (Roefs et al., 2005a). The negativity bias is not evidenced for food attitudes, rather, a positivity bias is observed.

Conclusions

This review has reported the methodological similarities and differences of studies investigating food attitudes using the affective priming paradigm. A focus on this methodology was important for understanding conceptually what was being reported in implicit attitude food research and why some studies failed to generate any effects. This review has identified that positive and negative targets paired with primes on dimensions of palatability and pleasantness generate an implicit food attitude priming effect. Implicit attitudes towards the fat content of different foods may be observed by analysing data using an implicit attitude index and not by basic analysis on reaction time.

A complete understanding of food attitudes and their influence on behaviour is yet to be achieved and the research reviewed here would be strengthened if behaviour had also been assessed. Behavioural assessments may include analysis of actual observed behaviour, self-reported behaviour (food diaries), or, due to the cognitive origin and information processing effects of attitudes, by electrophysiological behaviour (Ito & Cacioppo, 2007). This would help to provide a more complete model for the influence of implicit food attitudes on dietary behaviour.

References

Bellezza, F. S., Greenwald, A. G., & Banaji, M. R. (1986). Words high and low in pleasantness as rated by male and female college students. *Behavior Research Methods, Instruments, and Computers, 18*, 299-303.

Berridge, K.C. (1996). Experimental run time system (ERTS). In Roefs, A., Herman, C.P., MacLeod, C.M., Smulders, F.T.Y., & Jansen, A. (2005a). At first sight: how do restrained eaters evaluate high-fat palatable foods? *Appetite, 44,* 103-114.

Bradley, M. M., & Lang, P. J. (1999). Affective norms for English words (ANEW): Stimuli, instruction manual and affective ratings. *Technical report C-1, Gainesville, FL.* University of Florida: The Centre for Research in Psychophysiology.

Czyzewska, M., & Graham, R. (2008). Implicit and explicit attitudes to high- and low-calorie food in females with different BMI status. *Eating Behaviors, 9*, 303-312.

De Houwer, J. (2003). A structural analysis of indirect measures of attitudes. In Roefs, A., Quaedackers, L., Werriji, M. Q., Wolters, G., Havermans, R., Nederkoorn, C., van Breukelen, G., and Jansen, A. (2006). The environment influences whether high-fat foods are associated with palatable or with unhealthy. *Behaviour Research and Therapy, 44*, 715-736.

Dovidio, J. F., Kwakami, K., Johnson, C., Johnson, B., & Howard, A. (1997). On the nature of prejudice: Automatic and controlled processes. *Journal of Experimental Social Psychology, 33*, 510-540.

Fazio, R. H., Sanbonmatsu, D. M., Powell, M. C., & Kardes, F. R. (1986). On the automatic activation of attitudes. *Journal of Personality and Social Psychology, 50*, 229-238.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The Implicit Association Test. *Journal of Personality and Social Psychology, 74,* 1464–1480.

Herman, C. P., & Polivy, J. (1980). Restrained eating. In A. J. Stunkard (Ed.), *Obesity* (pp.208-225). Philadelphia: Saunders.

Hermans, D., & De Houwer, J. (1994). Affective and subjective familiarity ratings of 740 Dutch words. In Roefs, A., Quaedackers, L., Werriji, M. Q., Wolters, G., Havermans, R., Nederkoorn, C., van Breukelen, G., and Jansen, A. (2006). The environment influences whether high-fat foods are associated with palatable or with unhealthy. *Behaviour Research and Therapy, 44*, 715-736.

Hermans, D., Baeyens, F., Lamote, S., Spruyt, A., & Eelen, P. (2005). Affective priming as an indirect measure of food preferences acquired through odor conditioning. *Experimental Psychology, 52*, 180-186.

Ito, T. A., & Cacioppo, J. T. (2007). Attitudes as mental and neural states of readiness: Using physiological measures to study implicit attitudes. In B. Wittenbrink & N. Schwarz (Eds.), *Implicit Measures of Attitudes* (pp.125-158). New York: Guildford Press.

Kerkhof, I., Vansteenwegen, D., Baeyens, F., & Hermans, D. (2009). A picture-flavour paradigm for studying complex conditioning processing in food preference learning. *Appetite, 53*, 303-308.

Lamote, S., Hermans, D., Baeyens, F., & Eelen, P. (2004). An exploration of affective priming as an indirect measure of food attitudes. *Appetite, 42,* 279-286.

Nosek, B. A., & Banaji, M. R. (2001). The go/no-go association task. *Social Cognition, 19*, 625-666.

Ostafin, B. D., Palfai, T. P., & Wechsler, C. E. (2003). The accessibility of motivational tendencies toward alcohol: Approach, avoidance, and disinhibited drinking. *Experimental and Clinical Psychopharmacology, 11*, 294-301.

Overduin, J., & Jansen, A. (1996). Food cue reactivity in fasting and non-fasting subjects. *European Eating Disorders Review, 4*, 249-259.

Papies, E. K., Stroebe W., & Aarts, H. (2009). Who likes it more? Restrained eaters' implicit attitudes towards food. *Appetite, 53*, 279-287.

Perugini, M. (2005). Predictive models of implicit and explicit attitudes. *British Journal of Social Psychology, 44,* 29-45.

Roefs, A., & Jansen, A. (2002). Implicit and explicit attitudes towards high-fat foods in obesity. *Journal of Abnormal Psychology, 111*, 517-521.

Roefs, A., Herman, C. P., MacLeod, C. M., Smulders, F. T. Y., & Jansen, A. (2005a). At first sight: how do restrained eaters evaluate high-fat palatable foods? *Appetite, 44,* 103-114.

Roefs, A., Quaedackers, L., Werriji, M. Q., Wolters, G., Havermans, R., Nederkoorn, C., van Breukelen, G., and Jansen, A. (2006). The environment influences whether high-fat foods are associated with palatable or with unhealthy. *Behaviour Research and Therapy, 44*, 715-736.

Roefs, A., Stapert, D., Isabella, L. A. S., Wolters, G., Wojciechowski, F., & Jansen, A. (2005b). Early associations with food in anorexia nervosa patients and obsess people assessed in the affective priming paradigm. *Eating Behaviours, 6*, 151-163.

Strack, F., & Deutsch, R. (2004). Reflection and impulse as determinants of "conscious" and "unconscious" motivation. In J. P. Forgas, K. Williams, & S. Laham (Eds.), Social motivation: Conscious and unconscious processes. Cambridge, UK: Cambridge University Press.

van Strien, T., Frijters, J. E. R., Bergers, G. P. A., & Defares, P. B. (1986). The Dutch Eating Behaviour Questionnaire for assessment of restrained, emotional and external eating behaviour. *International Journal of Eating Disorders, 5*, 295-315.

van Strien, T., Herman, C., Engels, R. C. M. E., Larsen, J. K., & van Leeuwe, J. F. J. (2007). Construct validation of the Restraint Scale in normal-weight and overweight females. *Appetite, 49*, 109-121.

Veldhuizen, M. G., Oosterfoff, A. F., & Kroeze, J. H. A. (2010). Flavors prime processing of affectively congruent food words and non-food words. *Appetite, 54*, 71-76.

Verhulst, F., Hermans, D., Baeyens, F., Spruyt, A., & Eelen, P. (2006). Determinants and predictive validity of direct and indirect measures of recently acquired food attitudes. *Appetite, 46*, 137-143.

Wilson, T. D., Lindsey, S., & Schooler, T. Y. (2000). A model of dual attitudes. *Psychological review, 107*, 101-126.

Wittenbrink, B. (2007). Measuring attitudes through priming. In B. Wittenbrink & N. Schwarz (Eds.), *Implicit Measures of Attitudes* (pp.17-58). New York: Guildford Press.

An Exploration of the Implicit Food Attitudes of People with Type-1 Diabetes using Reaction-time and Electrophysiological Measures

Abstract

People with type-1 diabetes mellitus (T1DM) have to be aware of their dietary intake for health reasons and this study aims to investigate whether their food attitudes are different from non diabetic controls. Adult participants with T1DM (*n* = 12) and non diabetic controls (*n* = 12) were recruited to this affective priming study on food attitudes. Participants were exposed to picture primes from 3 food categories (high-fat sweet, high-fat savoury and low-fat) and to pictures of non-food items (i.e. chair, ball). Brain activity was recorded during the affective priming task using EEG to explore electrophysiological differences between the groups. The results found positive implicit and explicit attitudes towards all food-types with no group differences. The EEG data focussed on N200, P300 and LPP ERP's and group differences were observed for the N200 ERP. The T1DM group demonstrated a larger N200 than the control group in all food and non-food conditions suggesting that there are electro cortical differences in brain functioning between these two groups and reasons for this difference are presented.

1. Introduction

A common finding in the food attitude literature is that self-report measures do not correlate very well with dietary behaviours (Perugini, 2005). This discrepancy has led some researchers to investigate more automatic or implicit attitudes towards foods (Lamote et al., 2004; Roefs & Jansen, 2002).

A distinction between implicit and explicit attitudes was initially identified by cognitive psychologists researching unconscious (implicit) cognitions on behaviour (Stanley, Phelps & Banaji, 2008). Explicit attitudes are accessed consciously and processed explicitly, whereas implicit attitudes are largely unconscious and outside of a person's immediate awareness (Fazio et al., 1995). Implicit attitudes are automatic and considered to be the primary response to a stimulus whereas explicit attitudes are secondary, and are an alteration or filtered version of the implicit attitude. These alterations are believed to be context dependent and fit in with what a person expects within a given situation (Wittenbrink & Schwarz, 2007). As explicit attitudes are accessed consciously they can be measured with questionnaires, interviews or other self-report methods. The assessments of implicit attitudes however, require more sophisticated models because of their unconscious, automatic nature.

The most commonly employed methods for assessing implicit food attitudes are the Implicit Association Task (IAT; Greenwald, McGhee & Schwartz, 1998) and the Affective Priming Paradigm (APP; Fazio, Sanbonmatsu, Powell & Kardes, 1986). These measures are based on the theory of spreading activation (Collins & Loftus, 1975) and response conflict. Spreading activation suggests that concepts are richly interconnected in the brain and when one concept is activated i.e. cake, there is a passive spread of activation across related concepts i.e. cream, icing, candles, party etc (McPhearson & Holcomb, 1999). According to this theory conceptually related stimuli are processed more quickly than unrelated stimuli due to the effect of priming.

Measures of Implicit Attitudes

The APP records reaction times from the presentation of affectively valenced primes and targets to illicit implicit attitudes (Fazio et al., 1986). Participants are shown a prime stimulus for around 200ms before being presented with a target that they are asked to evaluate as positive or negative. When a prime and a target are from congruent categories (i.e. sunshine & happy) the information processing is faster than when they are from incongruent categories (i.e. pain & happy).

The IAT works slightly differently, based on the same theoretical principles (Greenwald et al., 1998). It presents two attribute concepts such as positive and negative stimuli and two target concepts (e.g. high-fat and low-fat food stimuli). Participants are asked to categorise the stimuli as quickly as possible, generally by pressing a left or right key on a keyboard, and reaction times are again recorded. The concepts are assigned either left or right key. When target and attribute concepts are presented alternately and randomly on different trials the strength of the association between them is demonstrated by faster reaction times on congruent trials. For example high-fat food words and positive words assigned to the same key illicit faster response times than high-fat food words and negative words. In this example, this would suggest a positive implicit attitude towards high-fat foods (Roefs & Jansen, 2002).

Implicit Food Attitudes

Lamote et al. (2004) pioneered the first study of implicit food attitudes and reported that pleasant and unpleasant food pictures could be used as prime stimuli to generate a priming effect. However, results on implicit food attitudes since Lamote et al. (2004) have not always confirmed this.

Studies have assessed implicit food attitudes based on palatability where participants were shown words or pictures of foods that had previously been rated as palatable or unpalatable by participants in the same study, or in a prior pilot study. Some studies have found an implicit effect of palatability where participants show implicit positive attitudes towards palatable foods (Papies et al., 2009; Roefs et al., 2005a), whereas other studies have not found this effect (Papies et al., 2009; Roefs et al., 2005b).

Attitudes towards the fat content of food items have also been assessed implicitly and again demonstrate differing results. Implicit attitudes towards low-fat foods were found to be both positive (Karpinski & Hilton, 2001; Richetin et al., 2007) and negative (Czyzewska & Graham, 2008), whereas some studies found no implicit attitude towards low-fat foods (Roefs et al., 2005b; Roefs et al., 2006). Similarly, implicit attitudes towards high-fat foods were found to be negative (Czyzewska & Graham, 2008; Roefs & Jansen, 2002) and positive (Czyzewska & Graham, 2008), with some studies finding no implicit attitude towards high-fat foods (Roefs et al., 2005a; Roefs et al., 2005b).

Czyzewska and Graham (2008) assessed both implicit and explicit food attitudes of women of different BMI groups. They found that implicit and explicit attitudes towards low-fat foods were negative for all participants. Overweight and healthy—weight women had positive implicit and explicit attitudes towards high-fat sweet foods and obese women had positive implicit and explicit attitudes towards high-fat savoury foods. However, differences in attitudes were reported where overweight and healthy-weight women had positive explicit attitudes towards high-fat sweet foods yet negative implicit attitudes. Moreover, obese women had positive explicit attitudes towards high-fat savoury foods and their implicit attitudes were found to be negative. This suggests that women in this study have different implicit and explicit attitudes towards some foods and this difference is moderated by BMI classification.

The differences found in these studies may be explained by a difference in methodology (IAT vs APP), in the prime categories used (high-fat vs high-fat sweet & savoury), in the populations studied (obese or healthy-weight, restrained or unrestrained eaters) or in the analysis of the implicit attitude (basic reaction time analysis vs implicit attitude index). There are a number of ways to analyse the reaction time data generated during implicit attitude studies and these are described below.

Units of measurement

Wittenbrink (2007) describes a stepped approach in measuring behaviourally acquired implicit attitudes starting with a basic analysis of differences in the reaction time mean scores. This approach is possibly too simple to be a valid measure of implicit attitude because the differences could occur independent to the prime and target relationship (Wittenbrink, 2007). An alternative approach to implicit attitudes involves computing an implicit attitude index based on the mean reaction time scores for each participant, which is then entered into a specific formula (of which there are a number) and these index scores form the data for the analysis. Slightly different statistical approaches have been used within the implicit food attitude research including an index based on median reaction time scores (Czyzewska & Graham, 2008), an index based on the mean reaction time scores (Roefs et al., 2005; Roefs et al., 2006), and basic differences in reaction time means with regression analyses (Papies et al., 2009).

A recent methodological advancement to enhance understanding of the neural mechanisms involved in implicit attitudes has been the use of direct measures of cortical activity during these reaction time based tasks (Bartholow et al., 2009; Li et al., 2008; O'Toole & Barnes Holmes, 2009; Zhang et al., 2006).

Event-related potentials and implicit attitudes

ERP's measure the electrical neuro-cortical activity associated with information processing (Ito & Cacioppo, 2000) and cognition (Patel & Azzam, 2005). Combined reaction time and ERP methods would lead to a greater understanding of implicit food attitudes by observing specific neural mechanisms relating to the information processing and decision making of the reaction time based tasks (Ito & Cacioppo, 2007). Attitude research has identified a number of important ERP components relevant to implicit information-processing by using IAT and APP methodologies during continuous EEG recording (O'Toole & Barnes-Holmes, 2009; Coates & Campbell, 2010; Zhang et al., 2010). These are described in Table 1.1 and components relevant to the hypotheses of the current study will be discussed in more detail.

Table 1.1 ERP components relevant to information-processing and implicit attitudes

Component	Information processing operations	Hypothesised neural sources	Study	Predictions
N1 (N100)	Selective attention	Peaks in frontal regions	Ito & Cacioppo, (2007)	Larger when stimuli is attended to
N2 (N200)	Response inhibition monitoring	Anterior or posterior regions	Coates & Campbell, (2010)	Larger (more negative) amplitude when prime and target are incongruent
P3 (P300)	Decision making Evaluative categorisation	Across the cortex	Li et al. (2008) Coates & Campbell, (2010)	Larger (more positive) amplitude when prime and target are affectively congruent
P3a	Automatic detection of novel stimuli	Fronto/central	Coates & Campbell, (2010)	As P300
P3b	Orientation towards a target	Parietal	Coates & Campbell, (2010)	As P300
N400	Semantic processing Monitoring affective conflict (between prime & target)	Anterior and posterior Centroparietal	Zhang et al. (2010) Bermeitinger, Frings & Wentura (2008) O'Toole & Barnes-Holmes (2009)	Larger (more negative) amplitude when prime and target are affectively incongruent
LPP (Late Positive Potential)	Categorisation process Demonstrates the negativity bias	Largest over parietal regions	Zhang et al. (2010)	Larger (more positive) amplitude when prime and target are affectively incongruent

N200. The N200 is believed to be associated with response inhibition and has been described as reflecting detections of errors within sets of stimuli and the correction of error responses (Kopp, Rist & Mattler, 1996). The N200 has been observed during tasks where a primed response is required to be inhibited in favour of an alternative response such as during the Go/No-go task, (Heil, Osman, Wiegelmann, Rolke & Henninghausen, 2000) the Eriksen Flanker task (Heil et al., 2000), the IAT (Coates & Campbell, 2010) and the APP (Bartholow et al., 2009).

The N200 was observed during an Eriksen flanker task on trials where participants were required to inhibit a primed response and the N200 was not observed on congruent trials or during neutral trials where no response was needed (Heil et al., 2000). This suggests that the results reflected active inhibitory activity rather than the passive detection of visually inconsistent stimuli (Heil et al., 2000).

An N200 component peaking around 270ms was identified as relevant to implicit attitudes in a study using the IAT where it was found to be significantly larger during incongruent trials where more processing was required to inhibit a prepotent response and generate a correct response as compared to congruent conditions (Coates & Campbell, 2010). This significant effect was larger over posterior regions of the scalp suggesting that these areas of the brain were more active at this time (Coates & Campbell, 2010).

Studies using APP methodology have found small (Bartholow et al., 2009) or absent (Zhang et al., 2006; Li et al., 2008) N200 effects where EEG amplitude did not differ significantly depending on prime and target congruency. These studies (Coates & Campbell, 2010; Bartholow et al., 2009; Zhang et al., 2010; Li et al., 2008) used a basic analysis of mean reaction times to assess implicit attitudes and this method of analysis may not capture the implicit attitude towards the prime stimuli (Wittenbrink, 2007).

P300. The P300 is believed to be a response to evaluative categorisation. Coates and Campbell (2010) found larger P300 amplitudes peaking around 500ms during congruent as compared to incongruent trials. The P300 congruency effect has not been observed during APP studies although it has been hypothesised (Bartholow et al., 2009). Both of these studies employed a basic analysis of reaction time data to generate implicit attitudes whereas O'Toole and Barnes-Holmes (2009) computed an index of the IAT effect using a specific algorithm (C4; O'Toole & Barnes-Holmes (2009) based on the reaction time data. In their study O'Toole and Barnes-Holmes continuously recorded EEG during an IAT procedure with attribute concepts of pleasant and unpleasant, and target concepts of insect and flowers (O'Toole & Barnes-Holmes, 2009). They do not report specific ERP components (such as P300) and do not report whether the wave form they refer to is negative or positive going which makes it difficult to compare with other studies. They report that congruent trials resulted in more positive activity compared to incongruent trials in central and parietal regions during a 300 to 400ms interval. At a 400- to 600ms interval the opposite effect was observed in frontal regions where incongruent trials led to more positive wave forms than congruent trials. They conclude that this is evidence for the use of higher cortical processing confirming that the IAT measures more than a semantic priming effect (O'Toole & Barnes-Holmes, 2009). These results may also reflect an interaction between the P300 and the LPP.

LPP. The Late Positive Potential is reported to be involved in emotional processing and as such, emotional stimuli usually illicit a larger LPP than neutral stimuli (Yen, Chen & Liu, 2010). The intrinsic relevance of the emotional stimuli determines whether additional processing occurs, creating the increased wave and this motivated attention suggests that significant stimuli are selectively processed because they pull on attentional resources (Schupp et al., 2004). The LPP is sensitive to and results in larger amplitudes for self-relevant than not-relevant stimuli (Ito & Cacioppo, 2000). Ito and Cacioppo (2000) assessed both implicit and explicit processing operations during a categorisation task and observed the LPP to peak at approximately 450-550ms and evoked larger amplitudes during congruent than incongruent trials. This finding has been replicated during an affective priming study using positive and negative picture primes and positive and negative word targets (Zhang et al., 2010).

In summary, EEG studies investigating implicit attitudes have found larger N200 and LPP components for incongruent than congruent trials suggesting that incongruent pairings require additional processing. In contrast, P300 components are found to be larger during congruent than incongruent combinations due to the characteristics of this ERP. Furthermore the LPP component is larger when attending to self-relevant information and when responding to negative stimuli (Ito & Cacioppo, 2000).

Analysis of the implicit attitudes recorded during studies using both reaction time and ERP methodology have involved a basic analysis of the reaction time mean scores which may not be a true reflection of the implicit attitude and may explain some of the differences or null findings reported (Wittenbrink, 2007). In one study using the IAT an implicit index was computed although the researchers did not report specific ERP components during their analysis which makes the results difficult to interpret. To increase understanding of the neural mechanisms associated with implicit attitudes an analysis of both basic reaction time scores and an implicit index will be jointly employed to make ERP predictions during the current study.

Event –related potentials and food pictures

A number of studies have assessed brain responses to food picture stimuli for example, Nijs, Franken and Muris (2008) demonstrated larger P300 and LPP waves following exposure to palatable and high-fat food pictures, compared to pictures of office items amongst both normal-weight and obese women. The increased amplitudes of these waves were specifically observed at central and posterior electrode sites suggesting a motivational relevance and reinforcing nature of food items (Nijs et al., 2008). This finding has not been consistently replicated, for example some studies report no differences in P300 amplitude to food pictures for overweight/obese hungry women (Nijs, Muris, Euser & Franken, 2010), low external eaters (Nijs, Franken & Muris, 2009), and for normal-weight and under-weight participants (Babiloni et al., 2011). In contrast, an increased P300 has been demonstrated for normal-weight satiated and hungry women (Nijs et al., 2010), satiated overweight/obese women (Nijs et al., 2010), and high-external eaters (Nijs et al., 2009). These differences suggest that it might be possible to identify increased motivation towards food items compared to neutral or non emotional items by observing larger amplitudes in P300 or LPP waves in some populations.

It is not clear whether implicit food attitudes are sensitive to the common ERP components because to date there are no published studies using both reaction time and ERP methods in this area. In addition, the evidence for obtaining implicit food attitudes using reaction time based methods alone is inconclusive. This may be due to the strength of the implicit association that previously assessed participants have held towards foods and a population with strong food attitudes may be more sensitive to both the reaction time and ERP methods (Lamote et al., 2004).

Populations with strong food attitudes

There are a number of populations known to have strong attitudes towards foods such as obese people and people with eating disorders. Implicit food attitudes of people with obesity have been assessed and demonstrate mixed findings as described above (Roefs et al., 2005; Czyzewska & Graham, 2008). Food attitudes of people with eating disorders have been assessed using the APP demonstrating no priming effect in relation to food primes (Roefs et al., 2005). A number of health conditions require patients to be constantly aware of the foods that they eat for the management or regulation of their condition, such as diabetes. People with diabetes may have strong food attitudes due to the focus that they are required to place on their dietary behaviours and there is currently no published research of the implicit food attitudes of people with diabetes using reaction time based measures.

Diabetes

A recent study investigating cortical responses to food stimuli of people with type-2 diabetes (T2DM) found a difference in the explicitly reported liking of high-fat foods and the brain response to high-fat food pictures using fMRI (Chechlacz, et al., 2009). Participants reported lower appetite ratings than non-diabetic controls matched on age, sex and BMI yet during an fMRI exercise they had stronger brain responses to foods in areas of the brain that were associated with reward (Orbital frontal cortex, OFC). This was modulated by dietary self-care because people with type-2 diabetes are advised to avoid high-fat foods (Chechlacz et al., 2009). For the fMRI exercise participants were asked to look carefully at 72 pictures (36 food & 36 non food) presented in a pseudorandom order. The food pictures varied in their content of fat, sugar and portion size. The fat content of the pictured food had a slightly larger effect on the brain responses of participants with diabetes providing evidence that they have stronger implicit associations to high-fat foods. Part of the pathology of T2DM includes an increased incidence of obesity and the evidence for implicit food attitudes in obesity is not clear (Roefs & Jansen, 2002). People with type 1 diabetes (T1DM) however, tend to be of a healthy-weight and it could be hypothesised that they have strong food attitudes because they have to be constantly aware of the types and amounts of the foods that they eat in order to maintain a healthy insulin level.

Food attitudes and T1DM

Food attitudes have not been implicitly assessed using both reaction-time and electrophysiological measures. People with T1DM have been selected here due to the hypothesis that they are likely to have strong food attitudes which will be more sensitive to the sophisticated methods of implicit attitude assessment. In addition, a more complete understanding of these attitudes specific to T1DM will facilitate better understanding of the processes underlying dietary self-care. To ensure a T1DM profile is elicited from this research, a comparison group consisting of non-diabetic controls will also be assessed.

Hypotheses

In line with previous research, it is hypothesised that explicit food attitudes will be similar for both groups and will reflect a preference for high-fat sweet and low-fat foods (Roefs & Jansen, 2002; Czyzewska & Graham, 2008). The T1DM group may show a greater implicit preference towards high-fat sweet foods because they are required to avoid or limit consumption of these foods. Moreover, this would be in line with the results found for patients with T2DM (Chechlacz et al., 2009).

Analysis of the implicit food attitude data will identify congruent and incongruent prime-target pairings and this will be used to inform the ERP hypotheses (i.e. if high-fat sweet foods are found to be positive, when it is paired with a positive word this will be a congruent pairing for the ERP predictions). The implicit data will be analysed in two ways to try to understand the neural mechanisms of information processing and decision making and it is hypothesised that these different analyses will elicit different implicit attitudes. If differences are found in the implicit attitudes they will predict different congruent and prime and target pairs which will lead to different ERP hypotheses. For example, if high-fat sweet foods are found to generate a positive implicit attitude then pairing this food picture with a positive word will form a congruent prime and target pair. This will help to identify the method that best predicts the neural mechanisms associated with implicit attitude assessment. To this end, it is expected that a larger (more negative) N200 will be observed when the prime picture and target word are incongruent and a larger (more positive) P300 will be observed when prime and target are congruent (Coates & Campbell, 2010). The LPP will be larger (more positive) when viewing food pictures instead of neutral pictures for the T1DM group because these will be viewed as more self-relevant. A larger LPP will be observed when the prime and target are incongruent across both groups (Zhang et al., 2010).

2. Method

Ethical clearance was gained for the study through the University ethical application process and evidence of this is presented in appendix 2.1.

Participants

Participants were recruited via e-mail correspondence to staff and student members in all departments of a large UK University to form a control group and a T1DM group. The recruitment poster and participant information sheet are available in appendix 2.2. Inclusion criteria included being an adult aged between 18 and 45-years, being able to read English and to respond to a questionnaire written in English, being non vegan or non vegetarian, to be free from other major illnesses including depression and eating disorders. For the T1DM group additional criteria were to have lived with diabetes for at least 3-years, and to have been stable on the current treatment regime for at least 6-months. Control participants were recruited in the same way and were matched for gender, age and BMI.

Table 2.1. Participant Characteristics

	T1DM Group	Control Group	*t(df)*	*p*
Age	27.8 SD 9.3	28.4 SD 8.3	*(22)*0.162,	*p*=0.873
Height (cm)	179.6 SD 6.6	178.1 SD 9.5	*(22)*-0.444	*p*=0.662

Weight (kg)	79.1 SD 11.1	76.0 SD 12.6	*(22)*-0.636	*p*=0.531
BMI	24.6 SD 3.9	23.9 SD 2.8	*(22)*0.534,	*p*=0.599
Blood Sugar (mmols)	11.4 SD 5.5	5.5 SD 0.8	*(22)*-3.67	*p*=0.004
How Hungry (10cm VAS)	2.9 SD 2.5	5.0 SD 2.2	*(17)*0.438	*p*=0.08

Materials and Apparatus

Blood Glucose. Blood sugar levels were measured using the finger prick method with an Accu-chek soft clix pro lancing device with lancets, an Accu-chek Aviva blood glucose meter and test strips.

Height and Weight. Weighing scales (kg) and a portable height measure (cm) were used to calculate BMI (m/Kg^2) for each participant. Height and weight were measured without shoes and wearing light clothing. Bulky items and pocket contents were removed.

The affective priming paradigm and the explicit food rating tasks were presented using E-Prime software on a Viglen Genie Intel(R) Core(TM)2 Duo computer and a 17inch monitor with a computer keyboard. The APP was conducted in two laboratories, a control lab where the experimenter was located and an experimental lab where the participant was located. Communication between the experimenter and the participant was maintained using a one-way video recorder and a two-way microphone and speaker system between the two rooms.

Measures

Demographic Information. Participants completed a demographic information sheet which gathered information about their date of birth, gender, handedness (right or left), height, weight, BMI, blood sugar level, Ethnicity, occupation, current illnesses, current medication, food allergies, the exclusion of any foods from their diet and whether they were currently dieting, when and what they last ate. Participants were also asked to rate how hungry they were on a 10-cm visual analogue scale. Diabetic participants were asked how long they had been diagnosed with their diabetes and what treatment regime they followed. All measures are included in appendix 2.3.

Quality of Life. World Health Organisation Quality of life-BREF (WHOQoL-BREF; World Health Organisation, 2004) was used to assess quality of life. The 26-item scale assesses four domains of quality of life, namely physical health, psychological health, social relationships and environment. In the current study, the Cronbach alpha coefficient was .89 for the total scale demonstrating good internal consistency across participants. The internal consistency for the separate domain scores were adequate for the physical health subscales (alpha was .74), social relationships (alpha was .80) and environment (alpha was .68) but the psychological health subscale had low internal consistency (alpha was .59). Responses were made using a 5-point Likert scale ranging from very poor/ very dissatisfied/ not at all/ never to very good/ very satisfied/ an extreme amount/ always.

Eating behaviour. The Dutch Eating Behaviour Questionnaire (DEBQ; Van Strien, Frijters, Bergers, & Defares, 1986). The DEBQ is a 33-item self-report questionnaire rated on a 5-point forced choice scale anchored to the left with 'never' and to the right with 'very often'. The total scale is made up of three subscales with 10-items measuring emotional eating, 10-items measuring external eating and the remaining 13-items measuring restrained eating. The scale has shown good internal consistency, which is supported in this study with a Cronbach alpha of .92. The subscales also demonstrated good internal consistency with a Cronbach alpha of .95, .77 and .91 for the emotional, external and restrained eating scales, respectively.

Dietary Self Efficacy. The Dietary Self-Efficacy scale (DSE; Senécal, Nouwen, & White, 2000) was used to assess participant's confidence in their ability to eat healthily on a regular basis. Participants are asked how confident they would be to stick to their diet in 30 commonly occurring situations. Responses are given on a 0-100 rating scale anchored to the left with 0 (Not at all confident) and to the right with 100 (totally confident). Internal consistency of the scale during this study was excellent with a Cronbach alpha of .95.

Diabetes Self-Care. The Summary of Diabetes Self-Care Activities (SDSCA; Toobert & Glasgow, 1994) is a self-report questionnaire that has been revised since the development of the original scale in 1994 (Toobert, Hampson & Glasgow, 2000). The scale used in this study was comprised of 12-items addressing four subscales; diet; exercise; medication and blood sugar testing. The diabetes participants were presented with this 12-item version whereas control participants were asked to complete a brief 4-item version of questions made up by the diet subscale. The internal consistency of the scale was good with a Cronbach alpha of .83 for the total scale. The exercise, medication and blood sugar testing subscales also demonstrated good internal consistency (.87, .97 and .84, respectively). The diet subscale however, demonstrated poor internal consistency with a Cronbach alpha of .24. There were two separate versions of this scale administered to the participants, as described above and this may have had an impact on the reliability.

Stimulus Selection and Timing of Trials in the Priming Task

An affective priming experiment was designed to measure implicit attitudes towards foods. Each trial began with a black fixation cross presented in the centre of a 17inch computer screen against a light grey background for 250ms. The picture stimulus was then presented for 200ms with an inter-stimulus interval of 50ms before the presentation of a target word. This gave a stimulus onset asynchrony (SOA) of 250ms. The target word remained on the screen until the participant made a response. All word and picture stimuli are available in appendix 2.4.

Food pictures were selected to represent 3 food groups high-calorie sweet foods (biscuits, cake, ice-cream); high-calorie non-sweet foods (chips, fried egg, pizza) and low-calorie foods (broccoli, salmon, rice cakes) with 25 pictures per group. In addition, 25 neutral non-food pictures (roses, basket ball, cushion) were sourced to act as control stimuli. All pictures were visually matched for shape, brightness, complexity and colour using jpeg file information.

Target words were presented in white lower case lettering on a light grey background. The positively (50) and negatively (50) valenced words were taken from the ANEW (Affective Norms for English Words) database (Bradley & Lang, 1999). This database provides normative information of valence, arousal and dominance for 1034 English words. The words used in this study differed significantly on valence (negative: M=2.12, SD=0.27 vs. positive: M=7.93, SD=0.32, $t(98)=97.41$, $p<0.001$) but not on arousal (negative: M=5.88, SD=0.94 vs. positive M=5.94, SD=0.92, $t(98)=0.35$, $p=0.7$). Positive words included carefree, excitement and laughter whereas negative words included betray, detest and execution (see appendix 2.4).

Each prime picture was randomly presented four times, twice with a positive target word and twice with a negatively valenced target word completing 400 trials in 4 blocks. Each block was separated by a scheduled rest break where the participant was instructed to take as long as they needed and to *'press any key to continue'* with the experiment.

Explicit food attitudes

Participants were re-shown the 75 food pictures one at a time in the centre of a computer screen. They were asked to indicate on a scale of 0-7 *'how much do you like this food'* and *'how much do you want to eat this food now'*. Responses and viewing time were recorded.

EEG Recording and Data Processing

EEG was recorded continuously with 128 active Ag/AgCl electrodes placed according to the 10-5 electrode system (Oostenveld & Praamstra, 2000), using a nylon ECI cap. Vertical eye movements were monitored by electrodes placed on the left eye infra-orbital region and horizontal by bipolar electrodes from outer canthi of the left and right eyes. However, for two participants Fp1 and Fp2 electrodes were used to record vertical and F9 and F10 electrodes to record horizontal eye movements for reference due to technical problems in recording with original electrodes. Additional electrodes were used as references and ground. This was done following skin conditioning using NuPrep EEG abrasive skin prepping gel (Aurora, USA), an alcohol wipe (Cheshunt, UK) and then removing any surface residue with a soft tissue (Kimtech, Surrey, UK). The face electrodes were secured in place with clear adhesive disks (Biosense Medical, New York, USA) and conductivity was enhanced using Parker Signa gel (Fairfold New

Jersey). Medipore soft cloth surgical tape (St Paul, MN) was placed over the electrodes to prevent any movement.

EEG and electro-occulogram (EOG) signals were amplified by BioSemi Active-Two amplifiers (Amsterdam, Netherlands) and sampled at 512 Hz. The continuous EEG recordings were off-line referenced to average of left and right mastoids and band pass filtered between 0.5 and 30 Hz (48 db/oct). EEG of two participants was band pass filtered between 1 and 30 Hz (48 db/oct) due to slow drift. Eye movement correction was done using the Graton, Coles, and Donchin (1983) method implemented in the Brain Vision Analyser.

Continuous EEG was segmented for correct trials in epochs from 400 ms before target-onset to 800 ms after target-onset to form 8 separate conditions made up of the 4 picture types (high-fat sweet; high-fat savoury; low fat; neutral) paired with both a positive or negative word. Epochs were discarded if the voltage exceeded $\pm$ 100 µ volt and only trials with correct responses were included in the analysis. Visual inspection of waveforms showed N200 (180-250ms), P300 (250-350ms) and Late positive potential (LPP; 550-700ms). Current source density (CSD) topographic maps of this activity showed sources in frontal and parieto-occipital regions. Based on the CSD maps, neighbouring electrodes showing greatest activity were analysed together to represent a particular scalp position. Table 2.2 shows the location of the source of the activity for N200, P300 and LPP and the corresponding electrode positions taken for analysis.

Table 2.2. Electrodes pooled for each location

Location	Negative going-wave (N200)	Positive-going wave (P300; LPP)
Left Frontal	C1, FC1, FCC1, FCC3	AFF5h, AFF7h, F3, F5
Right Frontal	C2, FC2, FCC2, FCC4	AFF6h, AFF8h, F4, F6
Mid Frontal	CZ, FCZ	AFZ, FZ
Left Posterior	PO3h, PO5h PPO3, PPO5	PO3h, PO5h, PPO1h, PPO3h
Right Posterior	PO6h, PO4h, PPO4, PPO6	PO4h, PO6h, PPO2h, PPO4h
Mid Posterior	POZ, PZ	POZ, PZ

Procedure

Participants were advised in advance not to put any styling products in their hair on the day of testing and to eat their usual breakfast before 8 am and then to refrain from eating. Appointments for all participants started at 9.30am.

Participants completed a demographic information sheet and the questionnaires. Blood glucose was measured and then height and weight were measured. After positioning of the face electrodes and EEG cap, instructions were read out and shown on a computer screen. The researcher started the affective priming programme from the control room. Participants followed standardised instructions which were part of the programme and asked them to press P (or Q) if the word shown was positive and press Q (or P) if the word shown was negative. The response keys were counter balanced across participants. Participants were informed that this was a word categorisation task and they were instructed to respond as quickly as possible. During the affective priming task participants were advised to remain as still as possible and to refrain from blinking during the task. This APP task was presented in 4 blocks, each interspersed with breaks. The length of each break was determined by the participant who was advised to 'press any key to continue' once they felt ready to go on. After the APP was completed participants were asked to rate the pictures used as prime stimuli in terms of how much they liked the food and how much they wanted to eat it now. At the end of the experiment, participants were debriefed and received £6 per hour (up to £15) for taking part.

3. Results

Demographic, biometric and questionnaire variables

T-Tests were carried out to determine the baseline differences between the groups. As expected, participants differed significantly on their pre-assessment blood-sugar readings with control participants recording significantly lower blood sugar scores than participants with diabetes p = .004. Due to this significant effect blood sugar level was entered as a covariate for all proceeding analyses. A significant difference in participants' scores on the physical activity subscale of the WHOQoL found that control participants scored higher than T1DM participants. No further group differences were found on any of the demographic, biometric or questionnaire measures (all p's > .08). Of particular interest in relation to the hypotheses, participants with diabetes did not differ significantly from control participants on restricted eating (p >.47). All means and standard deviations are presented in Table 3.1.

Table 3.1. Mean scores (SD) for Demographic, Biometric and Questionnaires Variables

	T1DM Group		Control Group	
Variable	*M*	*SD*	*M*	*SD*

Age		27.83	(9.34)	28.42	(8.30)
BMI		24.60	(3.86)	23.87	(2.77)
Blood Glucose		11.37**	(5.52)	5.48**	(0.84)
Self Efficacy		68.13	(13.36)	60.57	(15.67)
DEBQ	Emotional eating	1.82	(0.58)	2.04	(1.08)
	External eating	2.92	(0.53)	3.05	(0.49)
	Restricted eating	2.22	(0.83)	2.49	(0.99)
SDSCA Diet		2.92	(0.44)	2.88	(0.58)
WHOQoL	Physical activity	26.67*	(4.56)	30.33*	(2.90)
	Psychological health	22.00	(3.36)	23.17	(2.41)
	Social	10.83	(4.48)	11.08	(3.00)
	Environment	31.25	(3.93)	31.08	(4.14)

* $p < .05$. ** $p < .01$.

Explicit attitudes towards food

Direct ratings of food pictures: The means and standard deviations are presented in Table 3.2 and show positive explicit attitudes towards all food-types (high-fat savoury, high-fat sweet and low-fat) on a rating scale of 0-7. A one-way between-groups repeated measures ANOVA found no significant main (group or food-type) or interaction effects (group x food-type) all *p's* > .42[1]. There were no significant between or within-groups differences on explicit attitudes towards high-fat savoury, high-fat sweet, or low-fat foods (see Figure 3.1).

[1] Repeat analysis without using a covariate did not alter the outcome of the results, all *p*'s > .10.

Motivation to eat the food: A one-way between-groups ANOVA with repeated measures was performed on the desire to eat the food shown in the picture at the moment of generating the response (on a scale of 0-7). No significant main effects (group or food-type) or interaction effects (group x food-type) were found, all *p's*>.50. There were no significant between or within-groups differences on desire to eat high-fat savoury, high-fat sweet or low-fat foods at the time of testing (see Table 3.2 and Figure 3.2). However, when the analyses were run without using blood sugar as a covariate, a significant main effect for food-type (p = 0.01) and group (p = 0.02) were found.

Table 3.2. Explicit and Implicit Food Attitude Mean scores (SD)

Food Attitude Variable	T1DM Group		Control Group	
	M	*SD*	*M*	*SD*
Explicit food attitude (scale 0-7)				
High-fat savoury	4.54	0.94	4.64	1.09
High-fat sweet	4.50	1.73	5.06	0.99
Low-fat	4.06	0.96	4.19	1.43
Motivation to eat the food (scale 0-7)				
High-fat savoury	2.34	1.63	3.38	1.86
High-fat sweet	2.41	1.94	4.23	1.44
Low-fat	1.70	1.30	3.06	1.54

Implicit Attitude (reaction time)				
High-fat savoury x positive word	760.36	160.22	764.53	128.92
High-fat savoury x negative word	761.97	135.88	797.84	144.70
High-fat sweet x positive word	743.22	141.83	750.48	135.29
High-fat sweet x negative word	778.68	121.59	799.46	138.28
Low-fat x positive word	777.57	149.90	756.43	128.20
Low-fat x negative word	776.41	139.57	786.52	125.58
Neutral x positive word	762.84	121.30	769.81	166.61
Neutral x negative word	757.08	199.42	791.58	152.75
Implicit Attitude Index				
High-fat savoury	7.37	51.26	11.54	112.47
High-fat sweet	41.22	87.65	27.20	79.96
Low-fat	4.60	101.32	8.31	77.99

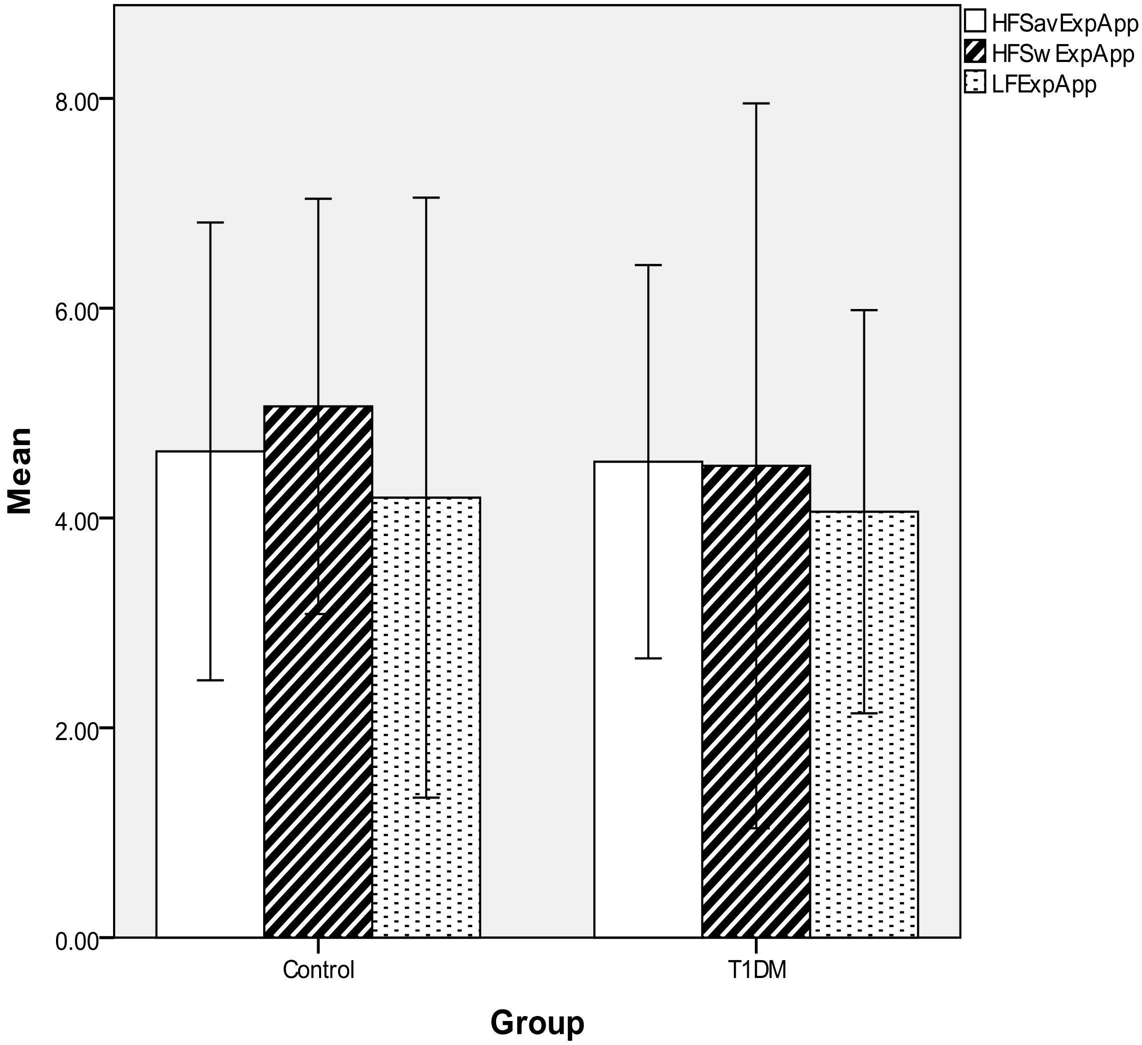


Figure 3.1. Mean and standard deviations of explicit ratings for High-fat savoury (HFSavExpApp), High-fat sweet (HFSwExpApp) and Low-fat foods (LFExpApp) on an 8-point scale from 0-7 for each group.

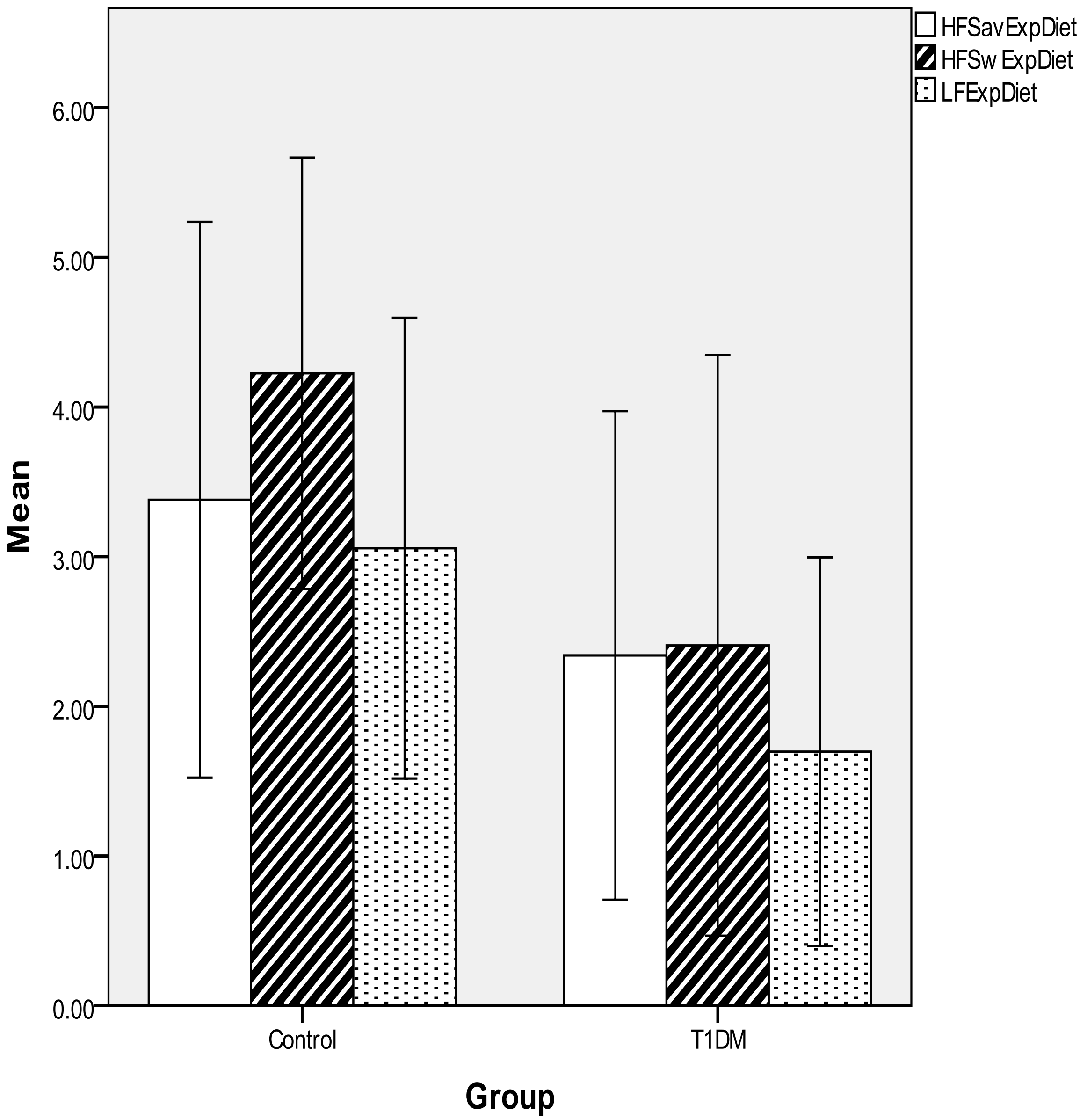


Figure 3.2. Mean and standard deviations of explicit ratings for the desire to eat High-fat savoury (HFSavExpApp), High-fat sweet (HFSwExpApp) and Low-fat foods (LFExpApp) at the time of assessment on an 8-point scale from 0-7 for each group.

Implicit attitudes towards food

Reaction time analyses: The response latencies (reaction times) recorded during the affective priming paradigm were used as the dependent variables for the implicit data analysis. Only accurate trials were included, which resulted in discarding 5.31% of the data set. Trials with response latencies less than 200ms and greater than 2000ms were also discarded (2.5%) from the total data set (Roefs et al., 2005; Roefs et al., 2006; Wittenbrink, 2007). Mean reaction times and standard deviations are presented in Table 3.2 and Figure 3.3.

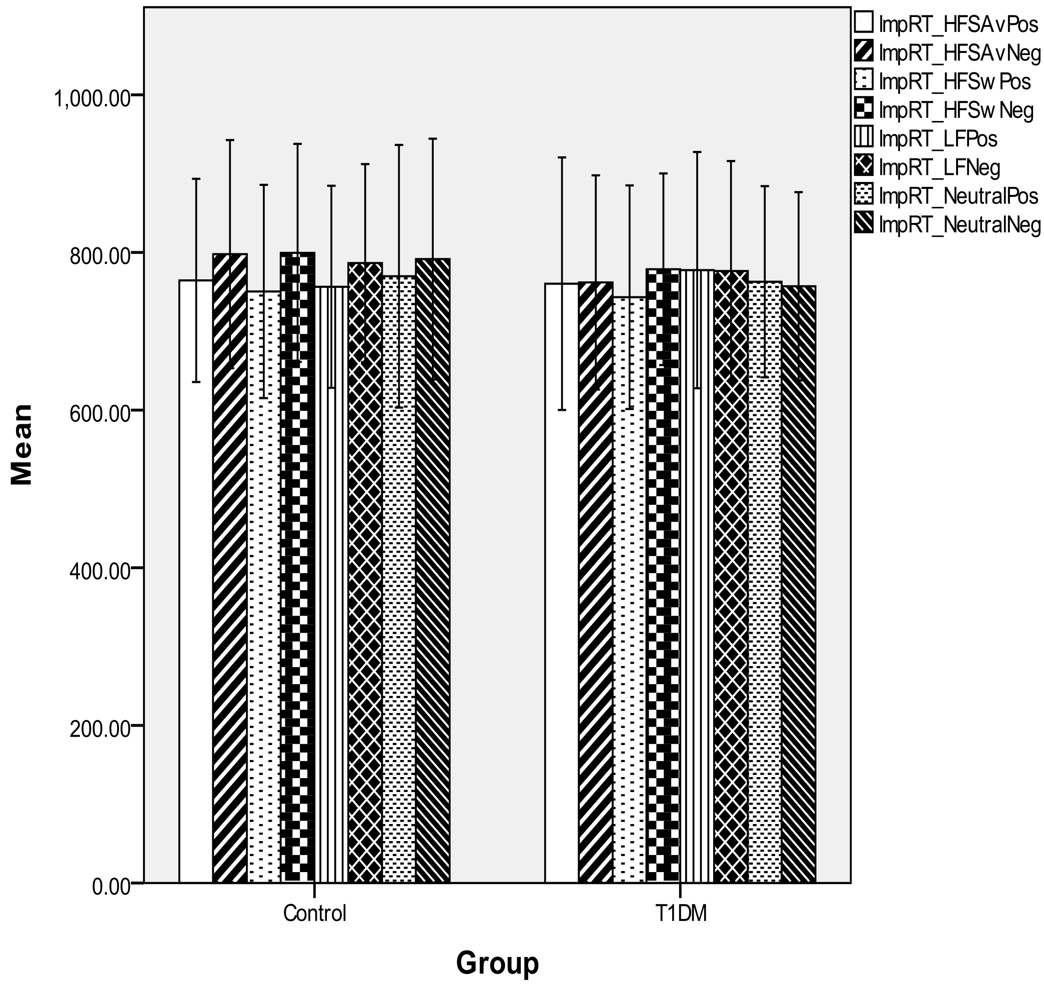


Figure 3.3. Mean reaction times (+*SD*) in response to each picture-type (ImpRT_HFSav; ImpRT_HFSw; ImpRT_LF; ImpRT_Neutral) paired with a positive (Pos) and a negative (Neg) word for each group.

A 4 (picture-type) x 2 (word valence) repeated measures ANOVA was conducted revealing a significant main effect of word valence *p*=.03 results of the analysis are presented in Table 3.3[2]. Inspection of the mean scores (Table 3.2) indicates that participants responded more quickly to positive words than negative words (computer keys were counterbalanced). This demonstrates the priming effect because all of the food pictures were explicitly rated as positive (Figure 3.1). Table 3.3 shows that no other effects reached significance (*p*>.69). Furthermore, no between-group differences were observed *F*(1,21)=.12, *p*=.75, eta squared=.01.

Table 3.3. Reaction Time and Implicit Attitude Index Repeated Measures ANOVA results with Covariate Blood Sugar

	Reaction Time Analysis			Implicit Attitude Index[a]		
Factors	(df) *F*	*p*	Eta	(df) *F*	*p*	Eta
Word valence[b]	**(1,21) 5.68**	**.03**	**.21**	-	-	-
Picture-type	(3,19) .04	.99	.01	(2,20) .19	.83	.02
Word valence x picture-type	(3,19) .16	.92	.03	-	-	-
Picture-type x group	(3,19) .50	.69	.07	(2,20) .21	.82	.02

[a]Implicit attitude index analyses attitudes towards the food pictures only [b]Word valence is not a factor for the implicit attitude index.

Implicit Attitude Index: An alternative method for analysing implicit attitude data is to compute an implicit attitude index (Roefs et al., 2005; 2006; Czyzewska & Graham, 2008; Wittenbrink, 2007). The mean reaction times for each participant during each picture category were used to

[2] When this analysis was repeated without the covariate, the significant main effect for word valence failed to reach significance, *p*=.06.All other findings were replicated.

compute the implicit attitude index (E_X). This was based on responses to the neutral ($_N$) pictures paired with positive (P) or negative (N) words and the food pictures ($_X$) with positive or negative words based on Wittenbrink (2007). Specifically the formula used on the mean reaction times was:

$$E_X = (P_N - P_X) - (N_N - N_X)$$

This generated three mean scores for each participant (high-fat savoury, high-fat sweet & low-fat) as Figure 3.4 and Table 3.2 show. Visual inspection of the mean scores illustrate a preference for high-fat sweet foods for both groups (Figure 3.4). A 3-way (picture-type) repeated measures ANOVA was performed on the implicit index data to investigate group differences of food-type and revealed no significant main or interaction effects all *p's* > .8 as shown in Table 3.3[3]. This non-significant effect may be due to the variance in the data as shown by the minimum and maximum implicit attitude index scores presented in Table 3.2 and the error bars in Figure 3.4.

[3] Repeat analysis without using a covariate did not alter the outcome of the results, all *p*'s>.17.

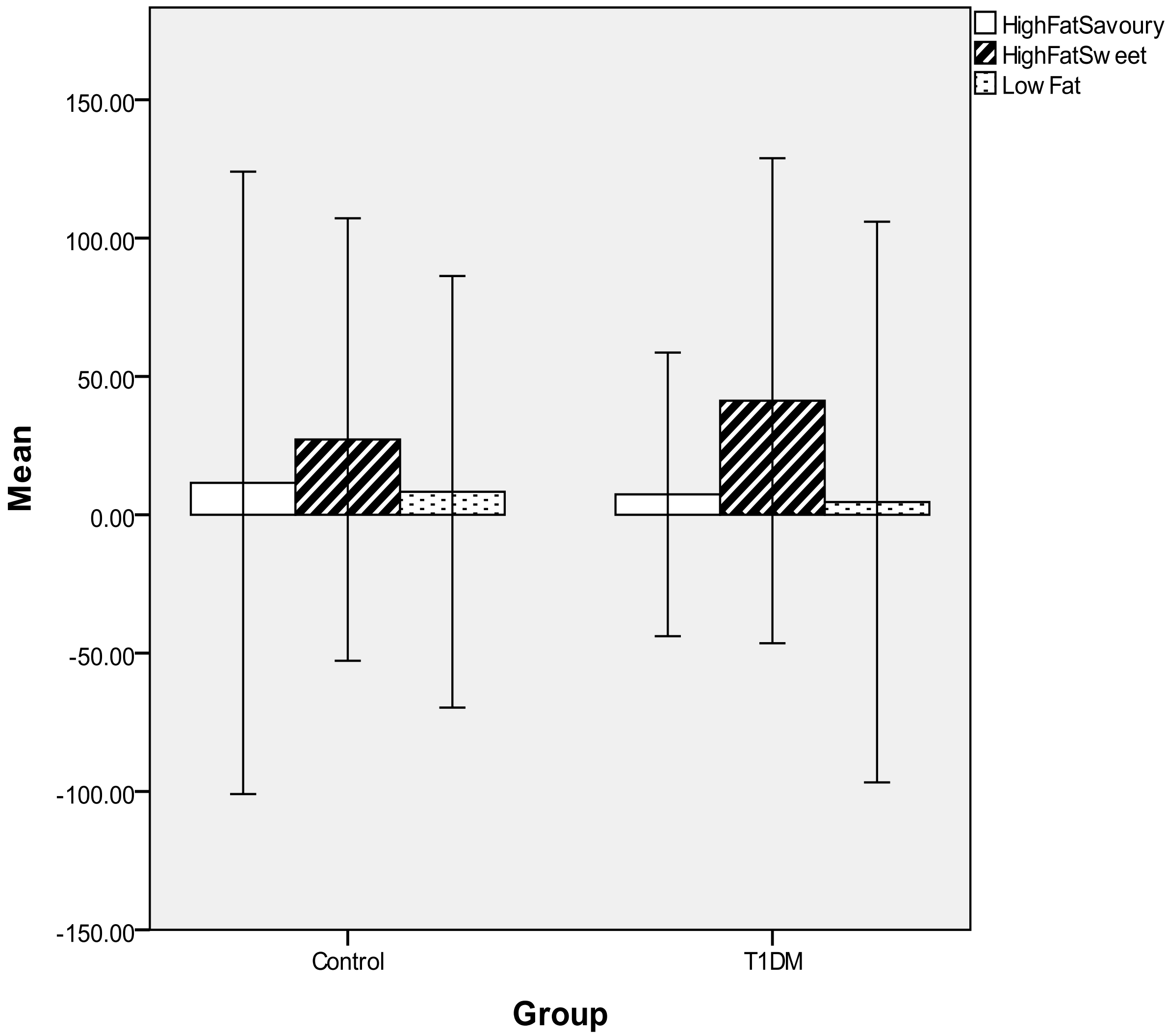


Figure 3.4. Implicit attitude index mean scores (+*SD*) for high-fat savoury, High-fat sweet, and Low-fat foods for each group.

ERP Results

Two sets of predictions were made of the ERP data based on reaction time and implicit attitude analyses to identify which provides a closer prediction of neural-activity and information processing during the affective priming paradigm. Explicit attitudes were positive for all food-types suggesting that the food-picture primes were positively valenced. The reaction time analysis predicts that congruent pairs will be observed with all food pictures when paired with a positive word. The attitude index analysis predicts that there will be no priming effect observed within the ERP data because none of the results reached significance.

Brain Activity

A 2 (site) x 3 (location) x 2(word valence) x 4 (picture-type) repeated measures ANOVA was conducted to compare activity separately for each ERP (N200; P300 and LPP). As with the implicit and explicit attitude analyses, blood sugar level, taken at the time of testing, was input as a covariate and for the ERP data the Greenhouse-Geisser corrections were applied to control for violations of sphericity.

The factors of interest were word valence and picture-type and an interaction between these factors did not reach significance for any ERP (all *p's*>.23)[4]. These interactions are nonetheless illustrated by group and for frontal and posterior sites in Figures 3.5, 3.6 and 3.7.

[4] Repeat analyses without using a covariate did not alter the outcome of the results, all *p's*>.13.

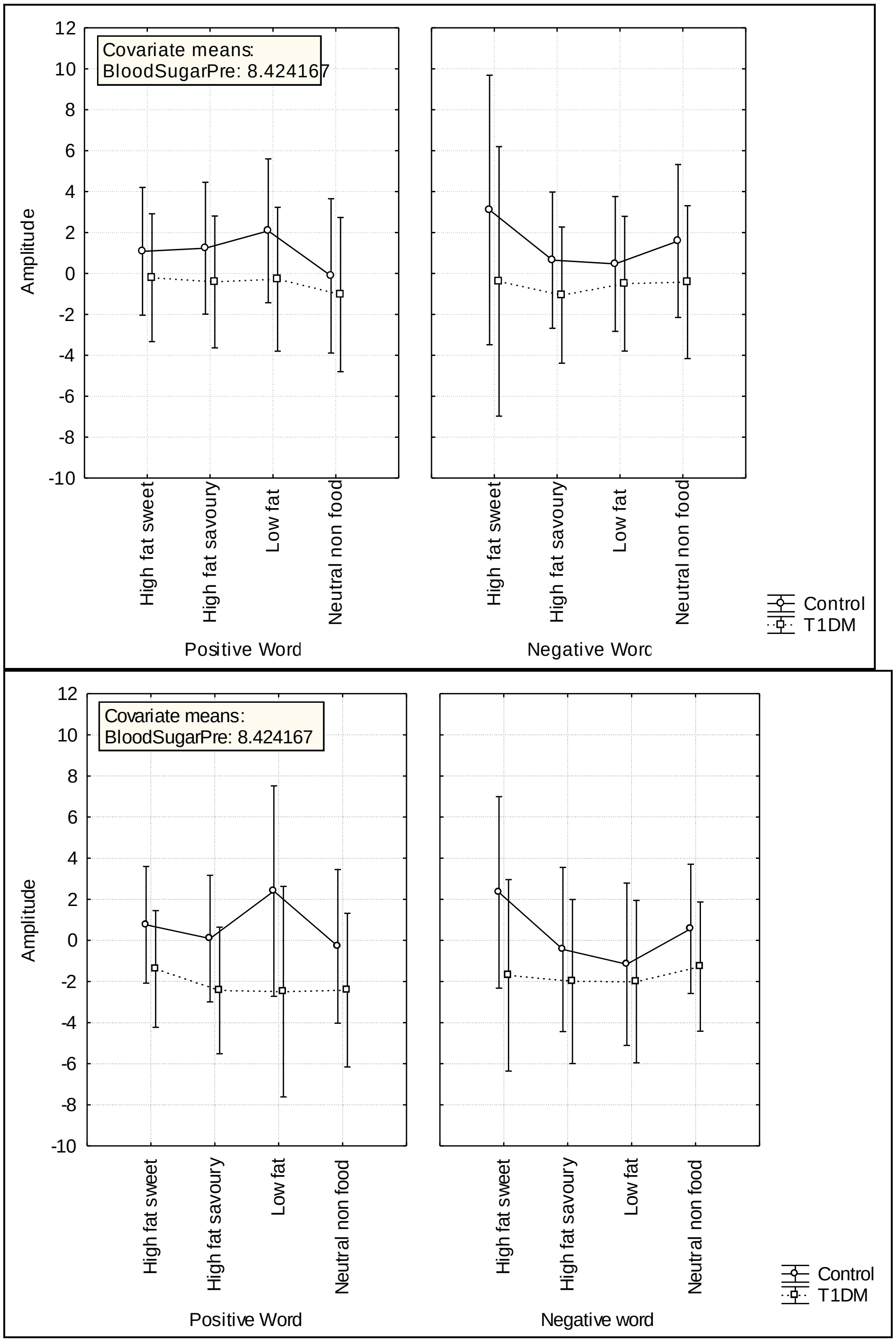


Figure 3.5. Results from a 2 (site) x 3 (location) x 2(word valence) x 4 (picture-type) repeated measures ANOVA on the N200 data illustrated for Frontal (Top graphs) and Posterior (Bottom graphs) sites.

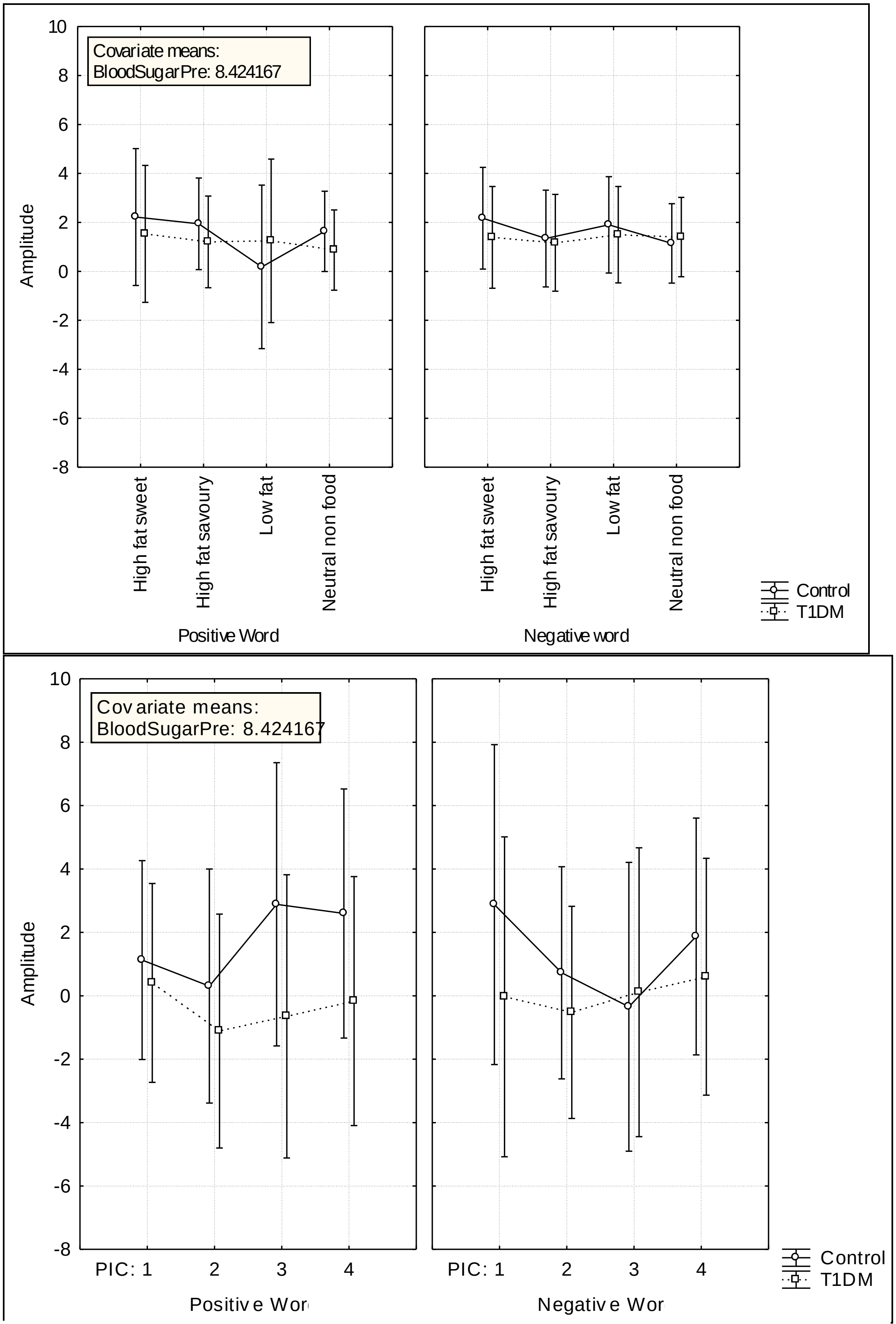


Figure 3.6. Results from a 2 (site) x 3 (location) x 2(word valence) x 4 (picture-type) repeated measures ANOVA on the P300 data illustrated for Frontal (Top graphs) and Posterior (Bottom graphs) sites.

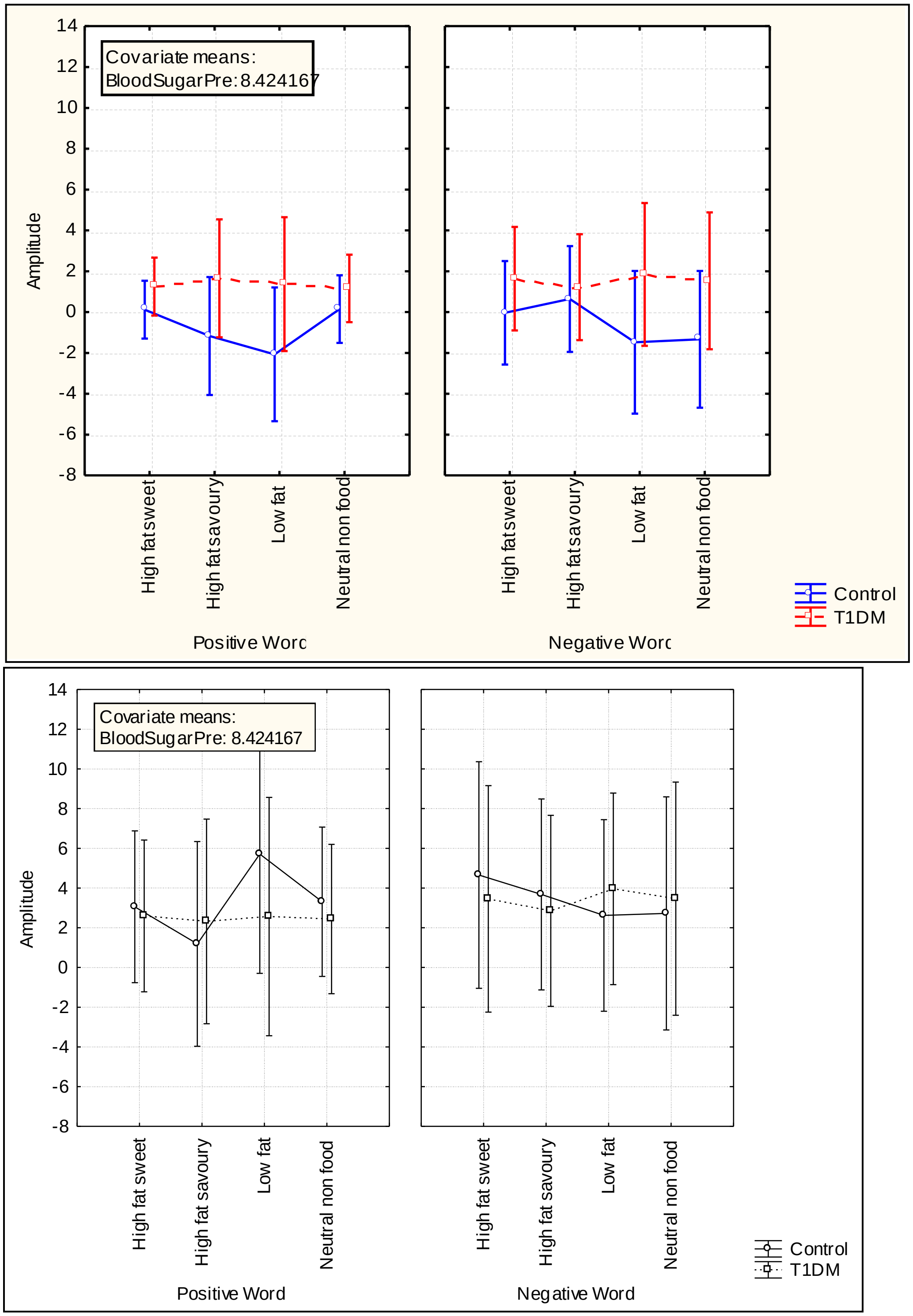


Figure 3.7. Results from a 2 (site) x 3 (location) x 2(word valence) x 4 (picture-type) repeated measures ANOVA on the LPP data illustrated for Frontal (Top graphs) and Posterior (Bottom graphs) sites.

The N200 data revealed a significant interaction of site x group x word valence $F(1,21) = 5.97$ $p = .02$, eta squared = .22 and this effect was supported by a significant main effect of group $F(1,21) = 6.68$, $p = .02$, eta squared = .24[5]. Inspection of the mean scores found that at frontal sites (left-frontal, mid-frontal & right-frontal) the T1DM group displayed negative amplitudes and the control group had positive amplitudes when responding to both positive and negative words. Figures 3.8 and 3.9 show the N200 for the high-fat sweet negative-word condition at the centro-parietal site (Pz) because the N200 is most pronounced at this site (Ito & Cacioppo, 1990) and the high-fat sweet data in Figure 3.5 demonstrates this discrepancy. Figure 3.8 shows that the T1DM group clearly demonstrate a negative deflection around 200ms post-stimulus and although the control group show a similar deflection it is not large enough to generate a negative amplitude. Figure 3.9 illustrates the topographical activity for each group.

[5] Repeat analyses without a covariate replicated these results with a significant site x group x word valence interaction $p = .03$, and a significant main effect for group $p = .03$.

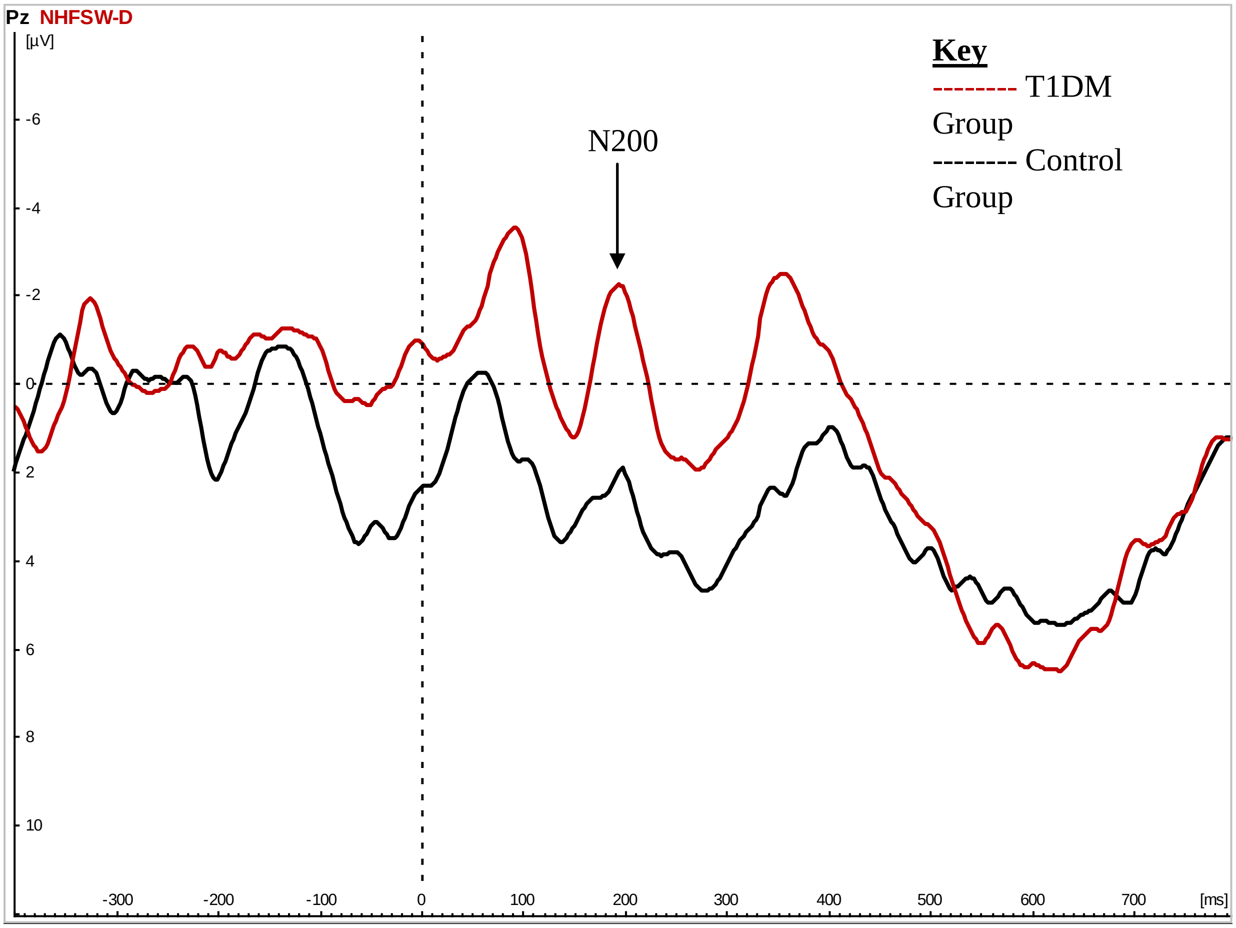


Figure 3.8
Grand average wave forms for T1DM and control groups when viewing a High-fat sweet food picture with a negative word at the centro-parietal site (Pz).

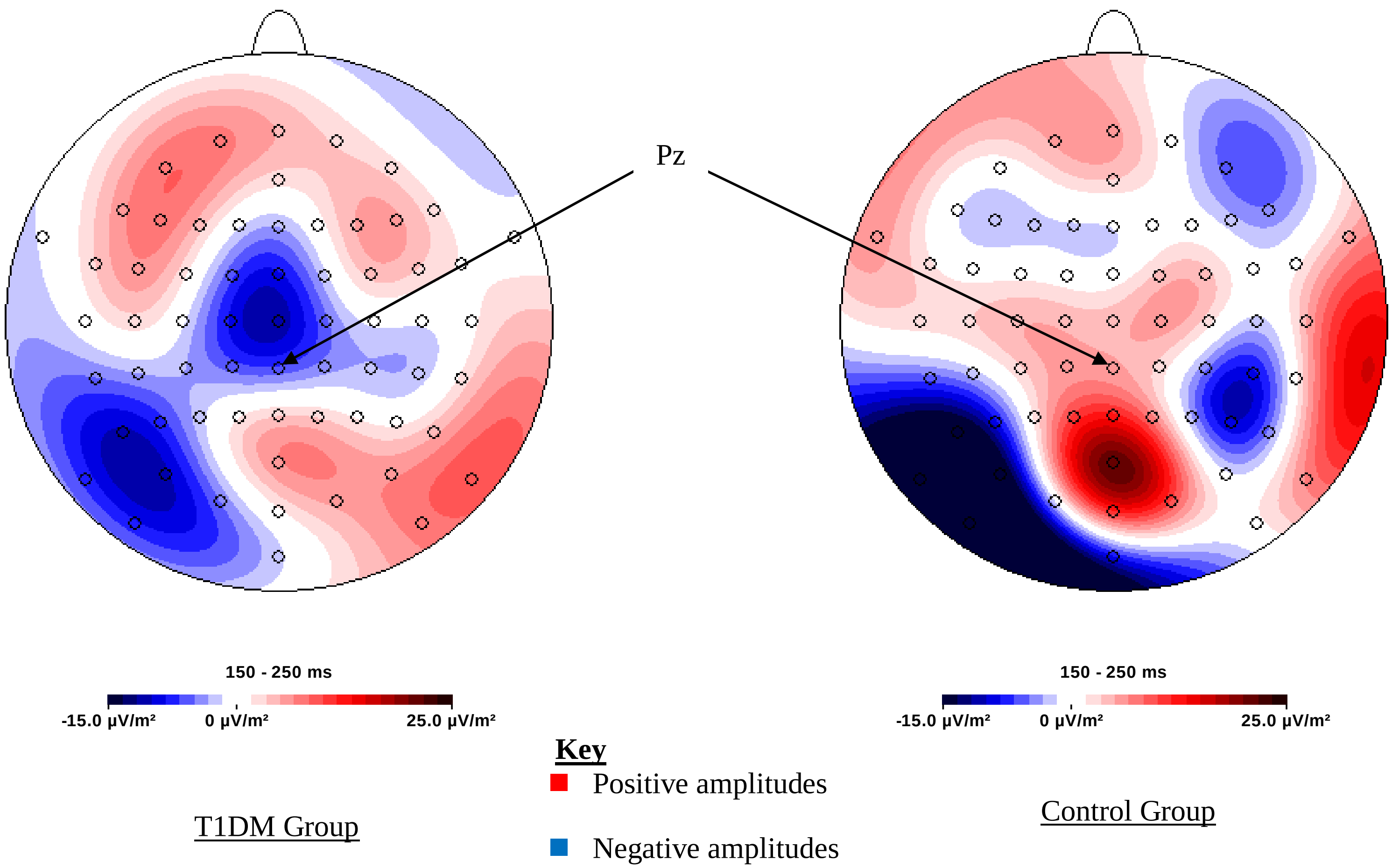


Figure 3.9.
Current source density (CSD) topographic maps of the grand averaged activity produced when T1DM and control participants are presented with a high-fat sweet food picture and a negative word at 150-250ms post-stimulus.

5. Discussion

The aims of this study were to explore the implicit and explicit food attitudes of people with T1DM in relation to a matched control group. All analyses were conducted using blood sugar as a covariate, however, analyses were also run without the covariate, which altered only the results of the explicit motivation to eat the food shown in the pictures and will be discussed below.

Food Attitudes. In line with the hypothesis, explicit food attitudes were similar for both groups and all food-types were rated positively. However, when the motivation to eat the foods shown in the pictures (at the time of testing) was analysed without a covariate the results were significant. The groups were found to respond significantly differently from one another, and a significant main effect for food type was observed. The control group demonstrate significantly higher levels of motivation to eat the foods shown at the time of testing than the T1DM group.

Implicit attitudes were analysed in two ways, firstly the reaction-time analysis showed that, overall, there was a positive bias towards food. However, contrary to the expectation, no significant group differences or food-type differences in implicit attitudes were found (Figure 3.3). The second analysis on the priming data, the implicit attitude index analysis revealed no priming effects suggesting that there were no differences in implicit attitudes towards the high-fat savoury, high-fat sweet or low-fat foods for both groups and no between-group differences.

There are a number of possible explanations for the absence of priming and group effects observed with this study. Firstly, there was a wide range of variance found within the implicit attitude index data and this may explain the non significant results. In addition, studies that have found significant results using an attitude index have recruited 80 or more participants (Czyzewska & Graham, 2008) and it may be that the numbers in this study were insufficient to identify a significant effect.

There have been three priming studies looking at implicit attitudes towards foods with different fat contents (Roefs et al., 2005a; Roefs et al., 2005b and Czyzewska & Graham, 2008). Two studies analysed the reaction-time data and found no differences between high- and low fat foods (Roefs et al., 2005a; Roefs et al., 2005b). The final study analysed an implicit attitude index and found differences in attitudes towards high-calorie sweet and high-calorie savoury foods (Czyzewska & Graham, 2008). The current study employed both forms of analysis replicating the findings of Roefs et al. (2005a) and Roefs et al. (2005b) and yet was unable to replicate the results of Czyzewska and Graham (2008), possibly due to the much larger sample size.

Furthermore, it is possible that the food primes used in this study were not emotionally charged enough to bring about a priming effect. Other food attitude studies using the fat content of food pictures or food words as primes have also failed to find a significant effect of priming, which supports the current results (Roefs et al., 2005a; Roefs et al., 2005b). Future studies would benefit from methods similar to Lamote et al. (2004) who asked participants to rate the palatability/un-palatability of potential food primes for inclusion in the study. This would ensure the direction of association with the food prime as positive or negative and would better predict a priming effect (Wittenbrink, 2007).

ERP Analysis. Studies in the literature discuss effects of congruence on ERP data, however, the congruence effect of this study was not obvious from the outset. As such, the priming paradigm was used to identify implicit attitudes based on congruent prime-target pairs. The priming paradigm data were analysed in two ways, which generated two sets of predictions on the effects of the ERP data. The ERP hypothesis based on the reaction-time data suggested that congruent pairings were comprised of any picture prime paired with a positive target because positive implicit attitudes were found towards all picture-types for both groups. The hypotheses of the LPP, P300 and N200 did not reach significance, however group differences in the N200 were observed and are discussed below. The attitude index data predicted that there would be no priming effects observed in the ERP data and this is what was found in the overall analysis. Thus, it could be concluded that the attitude index data directly predicts the ERP findings, however, a null result is not evidence of no effect and this is true to both the behavioural and electrophysiological data.

Studies using food picture stimuli found larger P300 (Nijs et al., 2008; Nijs et al., 2009; Nijs et al., 2010) and LPP waves (Nijs et al., 2008) for food pictures relative to non food pictures. However, these studies exposed their participants to food primes for between 100ms and 2000ms per trial without asking participants to categorise the stimuli and observed that food pictures received more attention than non food pictures. The priming paradigm requires participants to make a judgement about whether a target word is positive or negative and they are not asked to attend to the picture-primes in any particular way. This procedural difference (reduced attention towards the food-pictures) may explain why the late positive components were not found to be larger for food-pictures relative to non food-pictures during this study.

Furthermore, implicit attitude studies without using food stimuli have found larger LPP amplitudes for incongruent trials than congruent trials (Zhang et al., 2010) and larger P300 amplitudes for congruent than incongruent conditions (Coates & Campbell, 2009) reflecting the expected characteristics of these components. This current study found no effect of picture-type or congruence and this is possibly due to the effectiveness of the picture stimuli as a prime. Similar to the current study Bartholow et al. (2009) found no significant differences between congruent and incongruent word prime-target conditions for the P300 ERP.

<u>N200 Group Differences.</u> Group differences were evidenced by an absent N200 for the control group relative to the T1DM group (Figure 3.8) and indicates electrophysiological differences in information processing (Figure 3.9). The N200 ERP is believed to be a measure of response inhibition where an original response is inhibited in favour of an alternative/opposite response (Batholow et al., 2009). The N200 is expected to be larger on incongruent than congruent trials (Bartholow et al., 2009), although some implicit attitude studies have not found this effect (Coates & Campbell, 2009; Zhang et al., 2006; Li et al., 2008). The N200 has been observed in studies assessing implicit attitudes but has not been reported in studies using food pictures (e.g. Nijs et al., 2008; Nijs et al., 2009; Nijs et al., 2010) however it was observed during this study for the T1DM group. The N200 was found in frontal and posterior regions when the T1DM group observed any picture paired with any word with no differences based on stimuli presentation (Figure 3.5). The control group showed three negative mean scores in posterior regions, however there was a lot of variance in the data. This finding therefore, is not based on food attitudes and is more generally a difference between groups in the information processing of visually presented stimuli. It is currently unclear why people with T1DM show this effect and further studies are needed to understand these group differences.

Limitations. One limitation of the current study was that the treatment regime of participants in the T1DM group varied between fixed and flexible methods where some patients adjusted their insulin to match their food intake and other patients adjusted their food intake to match their insulin. This difference may explain some of the variance observed within the T1DM data and the different treatment methods may represent further clinical sub-groups that hold specific attitudes towards foods as a result of their diabetic management. This was not explored in the current study because the sample size was too small to perform sub-analyses. Future research would benefit from investigating the food attitudes of the T1DM population based on their diabetic management.

Another limitation for this study was the number of people involved. An a priori power calculation suggested that a planned sample size of 14 participants per group would generate a power of 0.80. There were 12 participants recruited to each group during this study. It is possible that with more participants more significant conclusions may be drawn from the data. Additional participants although potentially contributing to a more stable mean score, would also naturally contribute to the variance around the mean. Moreover, this study was a repeated measures design where each participant acted as their own control, which reduced the overall variance that would be present in an independent groups design. A post hoc power calculation based on the EEG data found that to generate a power of 0.80, we would have required data from over 100 participants per group.

Implications for Clinical Practice. The affective priming paradigm appears not to be an effective measure of implicit food attitudes based on fat content and other measures should be used to explore these attitudes such as the Implicit Attitude Task (Greenwald et al., 1998). Group differences observed in the N200 data suggest that T1DM and non diabetic control participants process visually presented stimuli in different ways.

Conclusion

To the best of my knowledge this study was the first to explore the implicit food attitudes of people with T1DM using a behavioural reaction-time method whilst continuously recording EEG activity. The study found positive implicit and explicit attitudes towards high-fat savoury, high-fat sweet and low-fat foods for both control participants and people with T1DM. Differences were observed between the groups in the N200 ERP suggesting that there are differences in the information processing of visually presented stimuli. However, this was found to be independent of food attitudes and of the hypotheses of this study, as such this finding warrants further research to explore exactly what the clinical implications of these differences might be.

References

Babiloni, C., Percio, C. D., Triggiani, A. I., Marzano, N., Valenzano, A., Petito, A., Bellomo, A., Soricelli, A., Lecce, B., Mundi, C., Limatola, C., & Cibelli, G. (2011). Attention cortical responses to enlarged faces are reduced in underweight subjects: An electroencephalographic study. *Clinical Neurophysiology, 122*, 1348-1359.

Bartholow, B. D., Riordan, M. A., Saults, J. S., Lust, S. A. (2009). Psychophysiological evidence of response conflict and strategic control of responses in affective priming. *Journal of Experimental Social Psychology, 45,* 655-666.

Bermeitinger, C., Frings, C., & Wentura, D. (2008). Reversing the N400: Event-related potentials of a negative semantic priming effect. *NeuroReport*, *19*, 1479-1482.

Bradley, M. M., & Lang, P. J. (1999). Affective norms for English words (ANEW): Stimuli, instruction manual and affective ratings. *Technical report C-1, Gainesville, FL.* University of Florida: The Centre for Research in Psychophysiology.

Chechlacz, M., Rotshtein, P., Klamer, S., Porubska, K., Higgs, S., Booth, D., Fritsche, A., Preissl, H., Abele, H., Birbaumer, N., & Nouwen, A. (2009). Diabetes dietary management alters responses to food pictures in brain regions associated with motivation and emotion: a functional magnetic resonance imaging study. *Diabetologia, 52,* 524-533.

Coates, M. A., & Campbell, K. B. (2010).Event-related potential measures of processing during an Implicit Association Test. *Cognitive Neuroscience and Neuropsychology, 21,* (16), 1029-1033.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review, 82*,(6), 407-428.

Czyzewska, M., & Graham, R. (2008). Implicit and explicit attitudes to high- and low-calorie food in females with different BMI status. *Eating Behaviors, 9*, 303-312.

Fazio, R. H., Jackson, J. R., Dunton, B. C., & Williams, C. J. (1995).Variability in automatic activation as an unobtrusive measure of racial attitudes: A bona fide pipeline? *Journal of Personality and Social Psychology, 69*, 1013-1027.

Fazio, R. H., Sanbonmatsu, D. M., Powell, M. C., & Kardes, F. R. (1986). On the automatic activation of attitudes. *Journal of Personality and Social Psychology, 50*, 229-238.

Gratton, G., Coles, M. G. H., & Donchin, E. (1983). A new method for off-line removal of ocular artefact. *Electroencephalography and Clinical Neurophysiology*, *55*, 468-484.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The Implicit Association Test. *Journal of Personality and Social Psychology, 74,* 1464–1480.

Heil, M., Osman, A., Wiegelmann, J., Rolke B., & Henninghausen, E. (2000). N200 in the Eriksen-Task: Inhibitory executive processes? *Psychophysiology, 14,* 218-225.

Ito, T. A., & Cacioppo, J. T. (2000). Electrophysiological evidence of implicit and explicit categorisation processes. *Journal of Experimental Social Psychology, 36*, 660-676.

Ito, T. A., & Cacioppo, J. T. (2007). Attitudes as mental and neural states of readiness: Using physiological measures to study implicit attitudes. In B. Wittenbrink & N. Schwarz (Eds.), *Implicit Measures of Attitudes* (pp.125-158). New York: Guildford Press.

Karpinski, A., & Hilton, J. L. (2001). Attitudes and Implicit Associations Test. *Journal of Personality and Social Behaviour, 81,* 774-788.

Kopp, B., Rist, F., & Mattler, U. (1996). N200 in the flanker task as a neurobehavioral tool for investigating executive control. *Psychophysiology, 33*, 282-294.

Lamote, S., Hermans, D., Baeyens, F., & Eelen, P. (2004). An exploration of affective priming as an indirect measure of food attitudes. *Appetite, 42,* 279-286.

Li, W., Zinbarg, R. E., Boehm, S. G., & Paller, K. A. (2008). Neural and behavioural evidence for affective priming from unconsciously perceived emotional facial expressions and the influence of trait anxiety. *Journal of Cognitive Neuroscience, 20*, 95-107.

McPherson, W. B., & Holcomb, P. J. (1999). An electrophysiological investigation of semantic priming with pictures of real objects. *Psychophysiology, 36,* 53-65.

Nijs, I. M. T., Franken, I. H. A., & Muris, P. (2008). Food-cue elicited brain potentials in obese and healthy-weight individuals. *Eating Behaviors, 9*, 462-470.

Nijs, I. M. T., Franken, I. H. A., & Muris, P. (2009). Enhanced processing of food-related pictures in female external eaters. *Appetite, 53*, 376-383.

Nijs, I. M. T., Muris, P., Euser, A. S., & Franken, I. H. A. (2010). Differences in attention to food and food intake between overweight/obese and normal-weight females under conditions of hunger and satiety. *Appetite, 54*, 243-254.

O'Toole, C., & Barnes-Holmes, D. (2009). Electrophysiological activity generated during the Implicit Association Test: A study using event-related potentials. *The Psychological Record, 59*, 207-220.

Oostenveld, R., & Praamstra, P. (2000). The five percent electrode system for high-resolution EEG and ERP measurements. *Clinical Neurophysiology, 112*, 713-719.

Papies, E. K., Stroebem W., & Aarts, H. (2009). Who likes it more? Restrained eaters' implicit attitudes towards food. *Appetite, 53*, 279-287.

Patel, S. H., & Azzam, P. N. (2005). Characterization of N200 and P300: Selected studies of the Event-Related Potential. *International Journal of Medical Sciences, 2*, 147-154.

Richetin, J., Perugini, M., Prestwich, A., & O'Gorman, R. (2007). The IAT as a predictor of spontaneous food choice: The case of fruits versus snacks. *International Journal of Psychology, 42*, 166-173.

Roefs, A., & Jansen, A. (2002). Implicit and explicit attitudes towards high-fat foods in obesity. *Journal of Abnormal Psychology, 111*, 517-521.

Roefs, A., Herman, C. P., MacLeod, C. M., Smulders, F. T. Y., & Jansen, A. (2005a). At first sight: how do restrained eaters evaluate high-fat palatable foods? *Appetite, 44*, 103-114.

Roefs, A., Quaedackers, L., Werriji, M. Q., Wolters, G., Havermans, R., Nederkoorn, C., et al. (2006). The environment influences whether high-fat foods are associated with palatable or with unhealthy. *Behaviour Research and Therapy, 44*, 715-736.

Roefs, A., Stapert, D., Isabella, L. A. S., Wolters, G., Wojciechowski, F., & Jansen, A. (2005b). Early associations with food in anorexia nervosa patients and obsess people assessed in the affective priming paradigm. *Eating Behaviours, 6*, 151-163.

Schupp, H.T., Junghofer, M., Weike, A. I., & Hamm, A. O. (2004). The selective processing of briefly presented affective pictures: An ERP analysis. *Psychophysiology, 41*, 441-449.

Senécal, C., Nouwen, A., & White, D. (2000). Motivation and dietary self-care in adults with diabetes: Are self-efficacy and autonomous self-regulation complementary of competing constructs? *Health Psychology, 19*,(5), 452-457.

Stanley, D. Phelps, E. A., Banaji, M.R. (2008). The neural basis of implicit attitudes. *Current Directions in Psychological Science, 17*, 164-170.

Stockburger, J., Weike, A. I., Hamm, A. O., & Schupp, H. T. (2008). Deprivation selectively modulates brain potentials to food pictures. *Behavioural Neuroscience, 122*, 936-942.

Toobert, D. J., & Glasgow, R. E. (1994). Assessing diabetes self-management: The summary of diabetes self-care activities questionnaire. In C. Bradley (Ed.), *Handbook of psychology and diabetes research and practice.* Berkshire, England: Hardwood Academic.

Toobert, D.J., Hampson, S. E., & Glasgow, R. E. (2000). The Summary of Diabetes Self-Care Activities Measure: Results from seven studies and revised scale**.** Diabetes Care, 23**,** 943-950.

Van Strien, T., Frijters, J. E. R., Bergers, G. P. A., & Defares, P. B. (1986). The Dutch Eating Behaviour Questionnaire for assessment of restrained, emotional and external eating behaviour. *International Journal of Eating Disorders, 5*, 295-315.

Wittenbrink, B., & Schwarz, N. (2007). Introduction. In B. Wittenbrink & N. Schwarz (Eds.), *Implicit Measures of Attitudes* (pp.1-16). New York: Guildford Press.

Wittenbrink, B. (2007). Measuring attitudes through priming. In B. Wittenbrink & N. Schwarz (Eds.), *Implicit Measures of Attitudes* (pp.17-58). New York: Guildford Press.

World Health Organisation, (2004).Quality of Life (WHOQoL)-BREF downloaded on September 28th 2010 from http://www.who.int/substance_abuse/research_tools/en/english_whoqol.pdf

Zhang, Q., Guo, C., Lawson, A., & Jiang, Y. (2006). Electrophysiological correlates of visual affective priming. *Brain Research Bulletin, 71*, 316-323.

Zhang, Q., Li, X., Gold, B. T., & Jiang, Y. (2010). Neural correlates of cross-domain affective priming. *Brain Research, 1329*, 142-151.

Public Dissemination Document

Implicit Food Attitudes in people with Type-1 Diabetes

Introduction: People with diabetes are advised to eat a healthy diet to help with the management of their illness. For people with type-1 diabetes mellitus (T1DM) there are a number of different treatment regimes to choose from including a flexible regime and a fixed regime. The flexible regime allows the patient to amend their insulin levels to match the food that they eat in order to have the right amount of insulin in the blood to keep them healthy. The fixed regime is a more traditional approach and the patient takes a set amount of insulin at set time and then matches what they eat to the insulin levels in their blood. Both types of treatment require the patient to have a good understanding of the qualities and characteristics of different food-types and what will keep them from feeling hungry whilst also being a healthy option.

Literature Review: We know from previous studies that people can have both explicit and implicit food attitudes. An explicit attitude is found when a person is asked directly what type of food they like, or asked to say how much they like a certain food. This attitude is something that the person knows that they have and is able to talk about. An implicit attitude is a more immediate reaction to the food and is something that the person might not be aware of, or might not want other people to know about. This type of attitude is more difficult to investigate but there are ways that people have developed to find this out. One of these ways is the affective priming paradigm (APP) and in relation to food attitudes this is a computer based task where a food item (picture or word) is shown quickly to a participant, for 200ms and then a word is shown. The words are positive (such as rainbow) or negative (such as funeral) and the participant is asked to indicate on the computer keyboard whether the word that is shown, is positive or negative. The APP measures how long it takes the person to respond to the word (reaction time). The theory of the APP suggests that a person will respond faster if the food item and the word hold the same emotion i.e. positive or negative. A food item will be positive if you like it and negative if you don't like it. If a person responds faster to a positive word relative to a negative word when it follows a picture of chocolate cake then they have a positive implicit attitude towards chocolate cake, therefore they like chocolate cake.

Previous studies where people have used the APP to learn about implicit food attitudes were searched for using electronic databases (PsycINFO, Web of Science and PubMed) and nine different papers were found that reported information from 14 studies. These studies used different types of words, pictures, smells and tastes to try to understand food attitudes from different types of people such as overweight, obese and normal weight people. Overall the studies found that the APP was a good way to measure whether people liked the tastes of different foods but it was not good to measure differences between foods that were high-fat or low-fat. This is because a person might like something high in fat in the same amount that they like something low in fat.

Rationale: The current study written about here was interested in how the food attitudes of people with T1DM might be different from the food attitudes of people without diabetes.

Methods: This study used questionnaires, the APP and Electroencephalogram (EEG) to learn about food attitudes. EEG is another way to find out about implicit food attitudes by looking at the activity of the brain when people are shown food items. This can be done using small electrodes that are gently plugged into a nylon cap and rest on the surface of the scalp. The electrodes pick up the electrical activity of the brain and store these brain signals on a computer. When the brain activity is recorded while the person takes part in the APP, as was done in this study, the brains response to different foods can be looked at.

This study was interested in the food attitudes of people with T1DM in relation to a non-diabetic control group. The control group were of similar age, gender and BMI status as the T1DM group. The food groups that were assessed during this study were high-fat sweet foods (chocolate, cake), high-fat savoury foods (chips, hamburgers), and low-fat foods (strawberries). There were 25 pictures of each different food type used in this study (75 food pictures in total) and 25 non-food pictures (such as chair and ball). In addition, there were 50 positive words and 50 negative words used in the APP task. After the APP participants were asked to rate on a scale of 0-7 how much they liked each of the 75 food pictures.

Results: Both groups had positive implicit and explicit attitudes to high-fat sweet, high-fat savoury and low-fat foods with no preferences for one over another. These results found no differences between the groups. However, there was a difference between the groups found in the brain activity of the people taking part in the study. At around 2-seconds after the target word had been shown the brain waves of people in the T1DM group were different to the non-diabetic group. The characteristics of this difference suggests that people with T1DM experience a conflict-response effect when asked to classify words as positive or negative after being shown a picture. The conflict response effect in this study suggests that when the picture is shown it generates the beginning of a response. If this response is the same as the word, i.e. both positive, then the conflict-response does not occur. When the original response is different to the word, the conflict response can be seen in the pattern of the brain wave. The non-diabetic group did not have this effect.

Conclusion: People with T1DM have similar explicit and implicit attitudes towards foods as non diabetic controls. The finding of no differences between the groups may have been due to the small number of people taking part in the study and working with more people may help to see differences. Also, the APP may not have been able to pick-up the implicit food attitudes that it was trying to find and another measure of implicit attitude may be more helpful such as the Implicit Attitude Task. Finally, differences were found in the brain waves of people with T1DM when viewing both food and non food pictures. This suggests that people with T1DM process visually presented information in a different way to people without diabetes and future research would be helpful to find out more about this.

Appendix 1.

Instructions for Authors

Appendix 2.1

Information for ethical review

Appendix 2.2

Recruitment e-mail and poster

Get Involved If...
You are:

- Aged between 18 and 45? ☐
- Able to read English and respond to a questionnaire written in English? ☐
- A non vegan, non vegetarian? ☐
- Free from other major illnesses (Including depression or an eating disorder) other than your diabetes? ☐

You have:

- Lived with your diabetes for at least 3 years? ☐
- Remained on your current treatment regime for at least 6 months ☐

Recruiting people with **Type 1 Diabetes** For an EEG study Paying £12*

Come along and get involved in research that can have a direct impact on what health professionals understand about Type 1 Diabetes.

What do I have to do?

Arrive at the University of Birmingham
Complete some questionnaires about your diabetes
Have your blood sugar tested
Sit in front of a computer screen (no computer skills required)
Have an EEG cap placed on your head by the researcher (a safe procedure)
Complete two computer based exercises
Your brain activity will be measured while you do the computer exercises

For further details contact Michelle Huggins on

[redacted]

This study takes place at the Univer **Birmingham** between February and A

UNIVERSITY OF BIRMINGHAM

Recruitment E-mail

Dear students,

We are hoping to learn about the food attitudes of **people with type 1 diabetes** compared to **people without diabetes**.

We will be looking at the way that the brain responds to a series of food pictures by using electro-encephalogram measures.

If you would like to learn more about this study and how to take part please reply to this e-mail or contact Michelle on [redacted]

People who choose to take part will be reimbursed for their time.

Many thanks
The research team

UNIVERSITY OF
BIRMINGHAM

Participant Information Sheet

Do people with type-1 diabetes have different attitudes towards food than people without diabetes?

Researchers: Michelle Huggins & Dr Arie Nouwen

What is the purpose of this research?

This study is part of a student research project for a doctorate qualification in clinical psychology. The purpose of the study is to find out whether people with type-1 diabetes have different attitudes towards food than people without diabetes. It is especially important for people with type-1 diabetes to eat foods that keep them healthy because this can help to manage their diabetes. If we know more about the attitudes of people with diabetes towards their food then we may be able to help improve their quality of care, through education and understanding.

Why have I been invited to take part?

You have been chosen to take part in this study because you are a member of the staff or student population at the University of Birmingham where the study will take place. There will be three groups that we want to learn about and people in one group will have type-1 diabetes, following a traditional insulin regime, group two will include people with type-1 diabetes who follow a flexible insulin regime and people in the third group will be healthy without diabetes. If you agree to take part you will be one of 14 people, with 3 groups of 14 people involved in the study and all of the information that we collect from you will be anonymised. This means that neither you, nor anyone else, will be able to identify yourself from the set of results.

What will happen to me if I agree to take part?

If you agree to take part you will be contacted by a member of the research team. At this time you can ask any further questions that you have about the study and a time will be arranged for you to come onto campus and complete the study. On the day you will be asked to sign a consent form. The study will take place in a psychology lab at the school of psychology where you will be asked to attend on one occasion for three hours. The study will take place in the morning and you will be asked to arrive at the lab to make a start at 9.30am. You will be asked to eat your usual breakfast before 8am and not to eat anything else until after the study.

There will be two parts to the study. Firstly you will be asked to complete a set of questionnaires, and secondly you will be asked to take part in some computer based tasks. It is not necessary for you to have any computer skills to take part in this study. The researcher will demonstrate the task for you and there will be an opportunity to practice before getting started.

This study is interested in which parts of the brain are active during the computer based tasks and we will be gathering this information using an electroencephalogram (EEG) machine. This is a non invasive procedure that will involve you wearing a cap on your head that the researchers will then attach electrodes too, like in the picture. The electrodes sit in jelly on your scalp and pick up information about the activity of the brain. There is a shower head, shampoo and a towel available for you to wash the jelly from your hair following the procedure. The long wires that are attached to the electrodes feed back to a small transmitter which receives the brain signals. The cap will take approximately 45 minutes for the researchers to put on you and you will be asked to wear it during the computer based parts of the study. Although very unlikely, if anything unusual or abnormal is picked on the EEG then we will inform your GP.

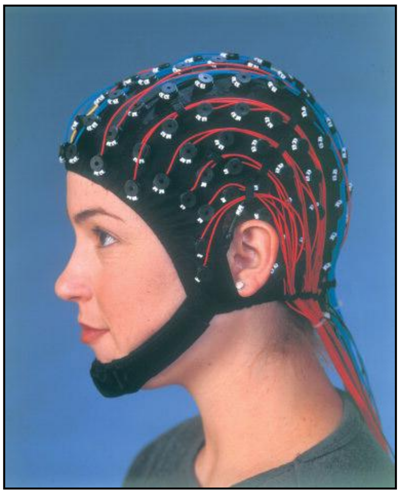


Figure 1: An EEG skull cap

You will be asked to fill out 4 short questionnaires and 2 rating scales. This should take no longer than 30 minutes. The questionnaires will ask about your well-being over the last few days and about your dietary habits. The two rating scales will ask you to rate some foods on how well you think that they taste and how healthy you think that they are.

During the second part of the study, once the cap is in place, you will be asked to take part in a computer based sorting task where you will be shown pictures of foods and words on the computer monitor. You will be asked to sort these items by pressing the right or left keys of the computer keyboard. We will be recording the time that it takes for you to press each key and how you choose to sort the items. To help with this you will be asked to work as quickly as possible. Next, you will be asked to select foods that you prefer to eat, from a set menu. This part of the study should last no more than 15 minutes.

An additional part of the information that we are interested in gathering is your height and weight, and your blood glucose reading. Your height and weight will be measured in the lab on our scales and portable height measure. Your blood glucose reading will be taken by finger prick method and measured using our Bayer machine. If you have diabetes, we will also ask you to take your own HbA1c measure using our Bayer machine.

What will happen if I do not want to carry on with the study?
Taking part in this research is entirely voluntary and it is up to you to decide whether or not to take part. You will be given at least three days to read through this information and discus it with whom ever you wish. If you do decide to take part, you will be asked to sign a consent form. You are still free to withdraw at any time and without giving a reason. Please be aware that all identifying information will be anonymised and if this research is accepted for publication we will not be able to withdraw your specific data from the published paper. A decision to withdraw at any time, or a decision not to take part, will not affect the standard of care you receive.

Expenses and payments
If you choose to drive onto campus and park in one of the pay and display car parks, your fee will be refunded.

What will happen to the results of the research study?
Part of the aims of this study will be to disseminate the information to a wider audience by publishing the results in a peer reviewed journal. If this occurs you will not be identified in any report or publication as all data will remain anonymous.

What happens if I have any further concerns?
If you are concerned or distressed about your participation in this study please let the researchers know either in person or using the contact details provided. We will be happy to talk to you about any difficulties that you have and if you need additional support we will recommend that you contact your GP.

If you would like to discuss any aspect of this research please contact Michelle Huggins on [redacted] or at the School of Psychology, Frankland Building, University of Birmingham, Edgbaston, B15 2TT.

Appendix 2.3

Measures Used

UNIVERSITY OF BIRMINGHAM

Consent Form

Research site: School of Psychology, University of Birmingham
Study Number & Title: Do people with type-1 diabetes have different attitudes towards food than people without diabetes?
Researcher: Michelle Huggins
Participant Identification Number:...

Please initial box

1. I confirm that I have understood the information sheet dated .... (version ...) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time during the research process, without giving any reason. ☐

3. I understand that the data collected during this study will be looked at by the researcher and relevant others at the University of Birmingham to ensure that the analysis is a fair and reasonable representation of the data. ☐

4. I agree to take part in the above study. ☐

....	....	....
Name of participant	Date	Signature
....	....	....
Name of researcher	Date	Signature

Appendix 1.0

GENERAL INFORMATION

Date: ___ ___ ___
D M Y

Number: ________

1. Date of birth: ___ ___ ___
D M Y

Age: _____

2. Sex: ___ Male ___ Female Handedness: Left: __
Right: __
Ambidextrous:__

3. Ethnicity: ___________________________________

4. Occupation: ___________________________________

5. Do you suffer from any illnesses or health problems including diabetes or any eating disorder? ___yes ___ no

If yes please could you state which health problems you suffer with:

____

____

____

6. Do you take any medication?

____

____

____

7. Do you have any food allergies? ___yes ___no

If yes please could you state which allergies you suffer with:

____

____

____

8. Do you exclude any foods from your diet due to personal, cultural or religious beliefs, such as vegetarianism? ___yes ___no

If yes please could you state which foods you exclude from your diet

____

____

____

9. Are you currently following a diet? ___yes ___no

If yes can you describe your diet, for example, Weightwatchers or a calorie restrictive diet?

____

____

____

10. How hungry are you?

Not at all

Hungry

11. At what time did you last eat? ____________

12. What did you eat and how much? Please list all, specifying when you ate and approximately how much you ate. Please include sauce, sugar, milk etc.

____

____

____

____
____

12. Height: ___________________cm Weight: ______________kg BMI: ____

13. Blood Sugar Pre: _____ Blood Sugar Post: ______

14. Duration of diabetes: None _____Diabetes for (approximately) ____ yrs ___ mths

15. Treatment Regime:____

Please answer ALL questions. Circle the appropriate response.

Do you have a desire to eat when you are irritated?	**not relevant**	**never**	**seldom**	**sometimes**	**often**	**very often**
If food tastes good to you, do you eat more than usual?		**never**	**seldom**	**sometimes**	**often**	**very often**
Do you have a desire to eat when you have nothing to do?	**not relevant**	**never**	**seldom**	**sometimes**	**often**	**very often**
When you have put on weight do you eat less than you usually do?	**not relevant**	**never**	**seldom**	**sometimes**	**often**	**very often**
Do you have a desire to eat when you are depressed or discouraged?	**not relevant**	**never**	**seldom**	**sometimes**	**often**	**very often**
If food smells good, do you eat more than usual?		**never**	**seldom**	**sometimes**	**often**	**very often**
How often do you refuse food or drink offered to you because you are concerned about your weight?		**never**	**seldom**	**sometimes**	**often**	**very often**
Do you have a desire to eat when you are feeling lonely?	**not relevant**	**never**	**seldom**	**sometimes**	**often**	**very often**
If you smell something delicious, do you have a desire to eat it?		**never**	**seldom**	**sometimes**	**often**	**very often**
Do you have a desire to eat when you somebody lets you down?	**not relevant**	**never**	**seldom**	**sometimes**	**often**	**very often**
Do you try to eat less at mealtimes than you would like to eat?		**never**	**seldom**	**sometimes**	**often**	**very often**
If you have something delicious to eat, do you eat it straight away?		**never**	**seldom**	**sometimes**	**often**	**very often**
Do you have a desire to eat when you are cross?	**not relevant**	**never**	**seldom**	**sometimes**	**often**	**very often**
Do you watch exactly what you eat?		**never**	**seldom**	**sometimes**	**often**	**very often**
If you walk past a baker, do you have a desire to buy something delicious?		**never**	**seldom**	**sometimes**	**often**	**very often**
Do you have a desire to eat when something unpleasant is about to happen?		**never**	**seldom**	**sometimes**	**often**	**very often**
Do you deliberately eat foods that are slimming?		**never**	**seldom**	**sometimes**	**often**	**very often**
If you see others eating, do you also have a desire to eat?		**never**	**seldom**	**sometimes**	**often**	**very often**
When you have eaten too much, do you eat less than usual the following day?	**not relevant**	**never**	**seldom**	**sometimes**	**often**	**very often**
Do you get the desire to eat when you are anxious, worried or tense?		**never**	**seldom**	**sometimes**	**often**	**very often**
Can you resist eating delicious foods?		**never**	**seldom**	**sometimes**	**often**	**very often**
Do you deliberately eat less in order not to become heavier?		**never**	**seldom**	**sometimes**	**often**	**very often**

Do you have a desire to eat when things are going against you and when things have gone wrong?		**never**	**seldom**	**sometimes**	**often**	**very often**
If you walk past a snackbar or café, do you have a desire to buy something delicious?		**never**	**seldom**	**sometimes**	**often**	**very often**
Do you have a desire to eat when you are emotionally upset?	**not relevant**	**never**	**seldom**	**sometimes**	**often**	**very often**
How often do you try not to eat between meals because you are watching your weight?		**never**	**seldom**	**sometimes**	**often**	**very often**
Do you eat more than usual, when you see others eating?		**never**	**seldom**	**sometimes**	**often**	**very often**
Do you have a desire to eat when you are bored or restless?	**not relevant**	**never**	**seldom**	**sometimes**	**often**	**very often**
How often in the evenings do you try not to eat because you are watching your weight?		**never**	**seldom**	**sometimes**	**often**	**very often**
Do you have a desire to eat when you are frightened?	**not relevant**	**never**	**seldom**	**sometimes**	**often**	**very often**
Do you take your weight into account with what you eat?		**never**	**seldom**	**sometimes**	**often**	**very often**
Do you have a desire to eat when you are disappointed?	**not relevant**	**never**	**seldom**	**sometimes**	**often**	**very often**
When preparing a meal, are you inclined to eat something?		**never**	**seldom**	**sometimes**	**often**	**very often**

The Who Quality of Life Questionnaire

SDSCA – Diabetes

The questions below ask about your diabetes self-care activities during the past 7 days. If you were ill during the past 7 days, please think back to the last 7 days that you were not ill. Please answer the questions as honestly and accurately as you can.

How often did you follow your recommended diet over the last 7 days ? (If you have not been given a specific diet by the diabetes care team, please answer according to the general guidelines you have been given).

Always	Usually	Sometimes	Rarely	Never
☐	☐	☐	☐	☐

How much of the time did you successfully limit calories as recommended in your healthy eating for diabetes control ?

None of the time	A little of the time	Some of the time	Most of the time	All of the time
☐	☐	☐	☐	☐

During the past week, how many of your meals included high fibre food, such as fresh fruits, fresh vegetables, and peas, bran ?

None of the them	A few of the them	Some of the them	Most of the them	All of the them
☐	☐	☐	☐	☐

During the past week, how many of your meals included high fat foods, such as butter, ice cream, oil, nuts and seeds, mayonnaise, fried food, salad dressing, crisps, pies, pizzas and sausages ?

None of the them	A few of the them	Some of the them	Most of the them	All of the them
☐	☐	☐	☐	☐

During the past week, how many of your meals included sweets and desserts, such as pastries, cake, jam, soft drinks (not diet), chocolate and cream biscuits?

None of the them	A few of the them	Some of the them	Most of the them	All of the them
☐	☐	☐	☐	

6) How often did you exercise the amount suggested by your doctor or diabetes nurse specialist ?

None of the time	A little of the time	Some of the time	Most of the time	All of the time
☐	☐	☐	☐	☐

7) On how many of the last 7 days did you exercise for at least 20 minutes ?

0	1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐	☐

8) On how many of the last 7 days did you exercise on top of what you do at school or as part of your work?

0	1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐	☐

9) On how many of the last 7 days (that you were not ill) did you did you test your glucose (blood sugar) level?

0	1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐	☐

10) Over the last 7 days how many of the glucose (blood sugar) tests recommended by your doctor did you actually do (covering all meals and pre bed) ?

None of the them	A few of the them	Some of the them	Most of the them	All of the them
☐	☐	☐	☐	☐

11) How many of your recommended insulin injections / medication did you take in the last 7 days that you were supposed to ?

All of them	Most of them	Some of them	None of them

12) How many of your recommended insulin injections / medication did you have at the time you were supposed to ?

All of them	Most of them	Some of them	None of them

☐ ☐ ☐ ☐

SDSCA – Controls

The questions below ask about your dietary eating habits during the past 7 days. If you were ill during the past 7 days, please think back to the last 7 days that you were not ill. Please answer the questions as honestly and accurately as you can.

How often did you follow a well-balanced diet over the last 7 days?

Always	Usually	Sometimes	Rarely	Never

During the past week, how many of your meals included high fibre food, such as fresh fruits, fresh vegetables, and peas, bran?

None of them	A few of them	Some of them	Most of them	All of them

During the past week, how many of your meals included high fat foods, such as butter, ice cream, oil, peanuts, mayonnaise, fried food, salad dressing, crisps, pies, pizzas and sausages?

None of them	A few of them	Some of them	Most of them	All of them

During the past week, how many of your meals included sweets and desserts, such as pastries, cake, soft drinks (not diet), chocolate and biscuits?

None of them	A few of them	Some of them	Most of them	All of them

APPRAISAL OF DIETARY PLAN: Diabetes

Certain situations which might make following a dietary plan for diabetes difficult are described below. For each of these situations, we would like to know how confident you are that you will be able to follow your dietary plan on a regular basis.

Using the scale below, please indicate how confident you are in your ability to follow your dietary plan on a regular basis by writing a number between 0 and 100 on the line provided. If the statement does not apply to your situation, please write N/A.

0	10	20	30	40	50	60	70	80	90	100
Not at all confident					Moderately confident					Totally confident

CONFIDENCE (0-100)

1. When watching television ________
2. When feeling tired or bored ________
3. When not working and at home ________
4. When feeling tense or preoccupied ________
5. When dining with friends who habitually have foods high in fat and/or sugar content ________
6. When preparing food for others ________
7. When eating at a restaurant ________
8. When feeling annoyed or angry ________
9. When very hungry ________
10. When feeling depressed ________
11. When taking the time to sit back and unwind ________
12. When taking the time to enjoy a good meal ________
13. When celebrating with others ________
14. When offered food that has high fat and/or sugar content ________
15. When a lot of foods high in fat and/or sugar content are available at home ________
16. When the recommended foods (low in fat and/or in sugar content, fruit, vegetables, etc.) are difficult to obtain ________

0	10	20	30	40	50	60	70	80	90	100
Not at all confident					Moderately confident					Totally confident

CONFIDENCE (0-100)

17. When craving foods with a high fat and/or sugar content ________
18. When ill ________
19. When we are entertaining others at home ________
20. When on holiday ________
21. When cleaning up after meals ________
22. During festivities, when appetising foods that have high fat and/or sugar content are being served ________
23. When pressed for time ________
24. When visiting another town or region and wanting to taste the local food________
25. When preparing my own meals ________
26. When faced with appealing foods that have high fat and/or sugar content in a supermarket ________
27. When my schedule doesn't go to plan ________
28. When I need to eat (snacks, regular meals) even though others are not eating ________
29. When feeling well ________
30. When I want more variety in my diet ________

Appraisal of healthy eating - Controls

Certain situations which might make following a healthy balanced diet difficult are described below. For each of these situations, we would like to know how confident you are that you will be able to maintain a healthy diet on a regular basis.

Using the scale below, please indicate how confident you are in your ability to maintain a healthy diet on a regular basis by writing a number between 0 and 100 on the line provided. If the statement does not apply to your situation, please write N/A.

0	10	20	30	40	50	60	70	80	90	100
Not at all confident					Moderately confident					Totally confident

	CONFIDENCE (0-100)
31. When watching television	________
32. When feeling tired or bored	________
33. When not working and at home	________
34. When feeling tense or preoccupied	________
35. When dining with friends who habitually have foods high in fat and/or sugar content	________
36. When preparing food for others	________
37. When eating at a restaurant	________
38. When feeling annoyed or angry	________
39. When very hungry	________
40. When feeling depressed	________
41. When taking the time to sit back and unwind	________
42. When taking the time to enjoy a good meal	________
43. When celebrating with others	________
44. When offered food that has high fat and/or sugar content	________
45. When a lot of foods high in fat and/or sugar content are available at home	________
46. When the recommended foods (low in fat and/or in sugar content, fruit, vegetables, etc.) are difficult to obtain	________

0	10	20	30	40	50	60	70	80	90	100
Not at all confident					Moderately confident					Totally confident

CONFIDENCE (0-100)

47. When craving foods with a high fat and/or sugar content ________
48. When ill ________
49. When we are entertaining others at home ________
50. When on holiday ________
51. When cleaning up after meals ________
52. During festivities, when appetising foods that have high fat and/or sugar content are being served ________
53. When pressed for time ________
54. When visiting another town or region and wanting to taste the local food________
55. When preparing my own meals ________
56. When faced with appealing foods that have high fat and/or sugar content in a supermarket ________
57. When my schedule doesn’t go to plan ________
58. When I need to eat (snacks, regular meals) even though others are not eating ________
59. When feeling well ________
60. When I want more variety in my diet ________

☐ ☐ ☐

Appendix 2.4
Word and picture stimuli

Word and Picture Stimuli used during the experiment

Table 1. Positive and Negative words used during the experiment

Positive Words		Negative Words	
acceptance	cute	abuse	demon
achievement	delight	accident	depressed
admired	desire	ache	depression
adorable	diamond	afraid	deserter
adventure	diploma	agony	despairing
affection	dog	alone	despise
angel	ecstasy	ambulance	detest
applause	engaged	anger	devil
aroused	enjoyment	anguished	disappoint
baby	excellence	assault	disaster
beach	excitement	bankrupt	discomfort
beautiful	fame	betray	disgusted
beauty	family	bomb	disloyal
bed	fireworks	burial	distressed
birthday	free	cancer	divorce
car	flirt	corpse	dreadful
carefree	freedom	crash	drown
caress	friend	crucify	enraged
cash	friendly	cruel	execution
champion	fun	crushed	failure
cheer	gift	dead	fat
christmas	hug	death	fearful
comedy	laughter	debt	filth
confident	love	defeated	funeral
cuddle	orgasm	deformed	gangrene

Table 2. High Fat Sweet Foods pictures used during the experiment

Picture	Name
	Biscuits
	Biscuits
	Biscuits
	Cheesecake
	Cheesecake

Cheesecake

Chocolate

Chocolate

Chocolate

Chocolate

Chocolate

Chocolate

Chocolate Cookies

Chocolates

Chocolates

Cupcake

Jam doughnut

Iced doughnut

Doughnuts

Ice cream

Ice cream

Ice cream

Muffin

Muffin

Pastry

Table 3. High Fat Savoury Food picture stimuli

Picture	Name

Almonds

Cashew nuts

Cheese

Cheese

Cheese

Chicken

Chicken

Chicken

Chips

Chips

Crisps

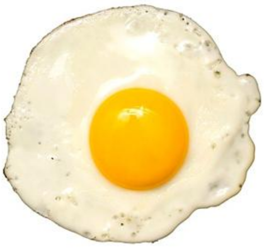
Crisps

Crisps

Croissant

Samosas

Fried Egg



Fish

Fish

Lamb

Onion rings

Onion rings

Peanuts

Pizza

Pizza

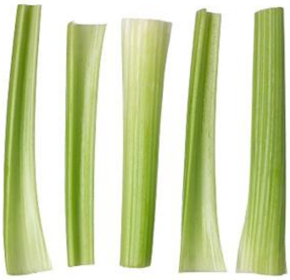
Pizza

Table 4. Low Fat Food picture stimuli

Picture	Name
	Asparagus
	Rye Bread
	Broccoli
	Carrots
	Carrots

Cauliflower

Celery



Chicken

Sweet corn

Sweet corn

Cucumber

Salmon

Fish

Lettuce

Peas

Peas

Pepper

Potatoes

Radishes

Raspberries

Rice

Rice cakes

Sprouts

Tomato

Tomatoes

Table 5. Neutral – Non Food picture stimuli

Picture	Name
	Baskets
	Roses
	Flip flops
	Cushion
	Bamboo
	Pencils
	Wheel

Cacti

Microphone

Towels

Helmet

Basket Ball

Telephone

Money

Stones

Twigs

Teapot

Bricks

Rose Petals

Ceramic Pot

Polished stones

Snooker Balls

Used bricks

Die

Bar of soap

Appendix 3

Additional Data

How much do you like this food (Scale 0-7) Descriptive Statistics

	Group	Mean	Std. Deviation	N
HighFatSavoury_App	Control	4.8483	1.06888	12
	T1DM	4.5367	.93738	12
	Total	4.6925	.99599	24
HighFatSweet_App	Control	5.1742	1.05662	12
	T1DM	4.4975	1.72754	12
	Total	4.8358	1.44247	24
LowFat_App	Control	4.3175	1.24144	12
	T1DM	4.0600	.96083	12
	Total	4.1888	1.09358	24

How much would you like to eat it no (Scale of 0-7)Descriptive Statistics

	Group	Mean	Std. Deviation	N
HighFatSavoury_Diet	Control	3.3800	1.85704	12
	T1DM	2.3400	1.63307	12
	Total	2.8600	1.79080	24
HighFatSweet_Diet	Control	4.2258	1.44082	12
	T1DM	2.4067	1.94013	12
	Total	3.3163	1.91217	24
LowFat_Diet	Control	3.0567	1.53944	12
	T1DM	1.6967	1.29889	12
	Total	2.3767	1.55654	24

IMPLICIT ANALYSIS

Picture type (4) x word valence (2) by group with covariate

Between groups RT Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.	Pa S
PictureType	Pillai's Trace	.010	.065[a]	3.000	19.000	.978	
	Wilks' Lambda	.990	.065[a]	3.000	19.000	.978	
	Hotelling's Trace	.010	.065[a]	3.000	19.000	.978	
	Roy's Largest Root	.010	.065[a]	3.000	19.000	.978	
PictureType * BloodSugarPre	Pillai's Trace	.006	.038[a]	3.000	19.000	.990	
	Wilks' Lambda	.994	.038[a]	3.000	19.000	.990	
	Hotelling's Trace	.006	.038[a]	3.000	19.000	.990	

	Roy's Largest Root	.006	.038[a]	3.000	19.000	.990
PictureType * Group	Pillai's Trace	.073	.497[a]	3.000	19.000	.689
	Wilks' Lambda	.927	.497[a]	3.000	19.000	.689
	Hotelling's Trace	.078	.497[a]	3.000	19.000	.689
	Roy's Largest Root	.078	.497[a]	3.000	19.000	.689
WordValence	Pillai's Trace	.308	9.347[a]	1.000	21.000	.006
	Wilks' Lambda	.692	9.347[a]	1.000	21.000	.006
	Hotelling's Trace	.445	9.347[a]	1.000	21.000	.006
	Roy's Largest Root	.445	9.347[a]	1.000	21.000	.006
WordValence * BloodSugarPre	Pillai's Trace	.213	5.675[a]	1.000	21.000	.027
	Wilks' Lambda	.787	5.675[a]	1.000	21.000	.027
	Hotelling's Trace	.270	5.675[a]	1.000	21.000	.027
	Roy's Largest Root	.270	5.675[a]	1.000	21.000	.027
WordValence * Group	Pillai's Trace	.007	.149[a]	1.000	21.000	.704
	Wilks' Lambda	.993	.149[a]	1.000	21.000	.704
	Hotelling's Trace	.007	.149[a]	1.000	21.000	.704
	Roy's Largest Root	.007	.149[a]	1.000	21.000	.704
PictureType * WordValence	Pillai's Trace	.048	.320[a]	3.000	19.000	.811
	Wilks' Lambda	.952	.320[a]	3.000	19.000	.811
	Hotelling's Trace	.051	.320[a]	3.000	19.000	.811
	Roy's Largest Root	.051	.320[a]	3.000	19.000	.811
PictureType * WordValence * BloodSugarPre	Pillai's Trace	.036	.238[a]	3.000	19.000	.869
	Wilks' Lambda	.964	.238[a]	3.000	19.000	.869
	Hotelling's Trace	.038	.238[a]	3.000	19.000	.869
	Roy's Largest Root	.038	.238[a]	3.000	19.000	.869
PictureType * WordValence * Group	Pillai's Trace	.025	.164[a]	3.000	19.000	.919
	Wilks' Lambda	.975	.164[a]	3.000	19.000	.919
	Hotelling's Trace	.026	.164[a]	3.000	19.000	.919
	Roy's Largest Root	.026	.164[a]	3.000	19.000	.919

a. Exact statistic

b. Design: Intercept + BloodSugarPre + Group

Within Subjects Design: PictureType + WordValence + PictureType * WordValence

Tests of Between-Subjects Effects

Measure:MEASURE_1

Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	18373774.427	1	18373774.427	127.614	.000	.859

BloodSugarPre	8331.653	1	8331.653	.058	.812	.003
Group	15227.363	1	15227.363	.106	.748	.005
Error	3023570.588	21	143979.552			

Implicit Index Between groups Tests of Between-Subjects Effects

Measure:MEASURE_1

Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Et
Intercept	194.160	1	194.160	.011	.917	
BloodSugarPre	6212.057	1	6212.057	.356	.557	
Group	1730.200	1	1730.200	.099	.756	
Error	366486.153	21	17451.722			

Implicit index between groups Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.	Pa S
PictureType	Pillai's Trace	.047	.497[a]	2.000	20.000	.616	
	Wilks' Lambda	.953	.497[a]	2.000	20.000	.616	
	Hotelling's Trace	.050	.497[a]	2.000	20.000	.616	
	Roy's Largest Root	.050	.497[a]	2.000	20.000	.616	
PictureType * BloodSugarPre	Pillai's Trace	.019	.191[a]	2.000	20.000	.828	
	Wilks' Lambda	.981	.191[a]	2.000	20.000	.828	
	Hotelling's Trace	.019	.191[a]	2.000	20.000	.828	
	Roy's Largest Root	.019	.191[a]	2.000	20.000	.828	
PictureType * Group	Pillai's Trace	.020	.206[a]	2.000	20.000	.815	
	Wilks' Lambda	.980	.206[a]	2.000	20.000	.815	
	Hotelling's Trace	.021	.206[a]	2.000	20.000	.815	
	Roy's Largest Root	.021	.206[a]	2.000	20.000	.815	

a. Exact statistic

b. Design: Intercept + BloodSugarPre + Group

Within Subjects Design: PictureType

N200 Repeated Measures ANOVA Mauchly's Test of Sphericity[b]

Measure:MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-	df	Sig.	Epsilon[a]

		Square			Greenhouse-Geisser	Huynh-Feldt	L
Site	1.000	.000	0	.	1.000	1.000	
Location	.933	1.390	2	.499	.937	1.000	
WordValence	1.000	.000	0	.	1.000	1.000	
PictureType	.176	34.221	5	.000	.483	.558	
Site * Location	.935	1.349	2	.509	.939	1.000	
Site * WordValence	1.000	.000	0	.	1.000	1.000	
Location * WordValence	.976	.477	2	.788	.977	1.000	
Site * Location * WordValence	.982	.358	2	.836	.983	1.000	
Site * PictureType	.494	13.910	5	.016	.743	.914	
Location * PictureType	.040	60.420	20	.000	.447	.567	
Site * Location * PictureType	.012	82.862	20	.000	.348	.424	
WordValence * PictureType	.121	41.620	5	.000	.473	.545	
Site * WordValence * PictureType	.600	10.060	5	.074	.743	.915	
Location * WordValence * PictureType	.009	89.152	20	.000	.368	.453	
Site * Location * WordValence * PictureType	.020	73.711	20	.000	.346	.421	

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportiona identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tes Subjects Effects table.

b. Design: Intercept + BloodSugarPre + Group

Within Subjects Design: Site + Location + WordValence + PictureType + Site * Location + Site * WordValence + Location * Wor Site * Location * WordValence + Site * PictureType + Location * PictureType + Site * Location * PictureType + WordValence * P Site * WordValence * PictureType + Location * WordValence * PictureType + Site * Location * WordValence * PictureType

N200 Repeated Measures ANOVA Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Site	Sphericity Assumed	645.350	1	645.350	4.708	.04
	Greenhouse-Geisser	645.350	1.000	645.350	4.708	.04
	Huynh-Feldt	645.350	1.000	645.350	4.708	.04
	Lower-bound	645.350	1.000	645.350	4.708	.04

Site * BloodSugarPre	Sphericity Assumed	385.885	1	385.885	2.815	.108
	Greenhouse-Geisser	385.885	1.000	385.885	2.815	.108
	Huynh-Feldt	385.885	1.000	385.885	2.815	.108
	Lower-bound	385.885	1.000	385.885	2.815	.108
Site * Group	Sphericity Assumed	21.786	1	21.786	.159	.694
	Greenhouse-Geisser	21.786	1.000	21.786	.159	.694
	Huynh-Feldt	21.786	1.000	21.786	.159	.694
	Lower-bound	21.786	1.000	21.786	.159	.694
Error(Site)	Sphericity Assumed	2878.572	21	137.075		
	Greenhouse-Geisser	2878.572	21.000	137.075		
	Huynh-Feldt	2878.572	21.000	137.075		
	Lower-bound	2878.572	21.000	137.075		
Location	Sphericity Assumed	69.677	2	34.838	2.755	.075
	Greenhouse-Geisser	69.677	1.874	37.177	2.755	.079
	Huynh-Feldt	69.677	2.000	34.838	2.755	.075
	Lower-bound	69.677	1.000	69.677	2.755	.112
Location * BloodSugarPre	Sphericity Assumed	25.953	2	12.976	1.026	.367
	Greenhouse-Geisser	25.953	1.874	13.847	1.026	.364
	Huynh-Feldt	25.953	2.000	12.976	1.026	.367
	Lower-bound	25.953	1.000	25.953	1.026	.323
Location * Group	Sphericity Assumed	11.070	2	5.535	.438	.648
	Greenhouse-Geisser	11.070	1.874	5.907	.438	.636
	Huynh-Feldt	11.070	2.000	5.535	.438	.648
	Lower-bound	11.070	1.000	11.070	.438	.515
Error(Location)	Sphericity Assumed	531.065	42	12.644		
	Greenhouse-Geisser	531.065	39.358	13.493		
	Huynh-Feldt	531.065	42.000	12.644		
	Lower-bound	531.065	21.000	25.289		
WordValence	Sphericity Assumed	2.364	1	2.364	.350	.560
	Greenhouse-Geisser	2.364	1.000	2.364	.350	.560
	Huynh-Feldt	2.364	1.000	2.364	.350	.560
	Lower-bound	2.364	1.000	2.364	.350	.560
WordValence * BloodSugarPre	Sphericity Assumed	1.249	1	1.249	.185	.672
	Greenhouse-Geisser	1.249	1.000	1.249	.185	.672
	Huynh-Feldt	1.249	1.000	1.249	.185	.672
	Lower-bound	1.249	1.000	1.249	.185	.672
WordValence * Group	Sphericity Assumed	1.488	1	1.488	.220	.644
	Greenhouse-Geisser	1.488	1.000	1.488	.220	.644
	Huynh-Feldt	1.488	1.000	1.488	.220	.644

	Lower-bound	1.488	1.000	1.488	.220	.644
Error(WordValence)	Sphericity Assumed	141.832	21	6.754		
	Greenhouse-Geisser	141.832	21.000	6.754		
	Huynh-Feldt	141.832	21.000	6.754		
	Lower-bound	141.832	21.000	6.754		
PictureType	Sphericity Assumed	38.013	3	12.671	.373	.773
	Greenhouse-Geisser	38.013	1.448	26.249	.373	.624
	Huynh-Feldt	38.013	1.675	22.690	.373	.654
	Lower-bound	38.013	1.000	38.013	.373	.548
PictureType * BloodSugarPre	Sphericity Assumed	4.977	3	1.659	.049	.986
	Greenhouse-Geisser	4.977	1.448	3.437	.049	.905
	Huynh-Feldt	4.977	1.675	2.971	.049	.929
	Lower-bound	4.977	1.000	4.977	.049	.827
PictureType * Group	Sphericity Assumed	28.096	3	9.365	.276	.843
	Greenhouse-Geisser	28.096	1.448	19.401	.276	.689
	Huynh-Feldt	28.096	1.675	16.770	.276	.722
	Lower-bound	28.096	1.000	28.096	.276	.605
Error(PictureType)	Sphericity Assumed	2138.949	63	33.952		
	Greenhouse-Geisser	2138.949	30.412	70.333		
	Huynh-Feldt	2138.949	35.182	60.796		
	Lower-bound	2138.949	21.000	101.855		
Site * Location	Sphericity Assumed	51.442	2	25.721	3.197	.051
	Greenhouse-Geisser	51.442	1.878	27.399	3.197	.055
	Huynh-Feldt	51.442	2.000	25.721	3.197	.051
	Lower-bound	51.442	1.000	51.442	3.197	.088
Site * Location * BloodSugarPre	Sphericity Assumed	18.545	2	9.272	1.152	.326
	Greenhouse-Geisser	18.545	1.878	9.877	1.152	.324
	Huynh-Feldt	18.545	2.000	9.272	1.152	.326
	Lower-bound	18.545	1.000	18.545	1.152	.295
Site * Location * Group	Sphericity Assumed	4.182	2	2.091	.260	.772
	Greenhouse-Geisser	4.182	1.878	2.227	.260	.759
	Huynh-Feldt	4.182	2.000	2.091	.260	.772
	Lower-bound	4.182	1.000	4.182	.260	.610
Error(Site*Location)	Sphericity Assumed	337.934	42	8.046		
	Greenhouse-Geisser	337.934	39.428	8.571		
	Huynh-Feldt	337.934	42.000	8.046		
	Lower-bound	337.934	21.000	16.092		
Site * WordValence	Sphericity Assumed	1.839	1	1.839	.542	.470
	Greenhouse-Geisser	1.839	1.000	1.839	.542	.470

	Huynh-Feldt	1.839	1.000	1.839	.542	.470
	Lower-bound	1.839	1.000	1.839	.542	.470
Site * WordValence * BloodSugarPre	Sphericity Assumed	3.845	1	3.845	1.134	.299
	Greenhouse-Geisser	3.845	1.000	3.845	1.134	.299
	Huynh-Feldt	3.845	1.000	3.845	1.134	.299
	Lower-bound	3.845	1.000	3.845	1.134	.299
Site * WordValence * Group	Sphericity Assumed	20.243	1	20.243	5.968	.023
	Greenhouse-Geisser	20.243	1.000	20.243	5.968	.023
	Huynh-Feldt	20.243	1.000	20.243	5.968	.023
	Lower-bound	20.243	1.000	20.243	5.968	.023
Error(Site*WordValence)	Sphericity Assumed	71.229	21	3.392		
	Greenhouse-Geisser	71.229	21.000	3.392		
	Huynh-Feldt	71.229	21.000	3.392		
	Lower-bound	71.229	21.000	3.392		
Location * WordValence	Sphericity Assumed	.624	2	.312	.684	.510
	Greenhouse-Geisser	.624	1.954	.319	.684	.507
	Huynh-Feldt	.624	2.000	.312	.684	.510
	Lower-bound	.624	1.000	.624	.684	.417
Location * WordValence * BloodSugarPre	Sphericity Assumed	.612	2	.306	.671	.517
	Greenhouse-Geisser	.612	1.954	.313	.671	.513
	Huynh-Feldt	.612	2.000	.306	.671	.517
	Lower-bound	.612	1.000	.612	.671	.422
Location * WordValence * Group	Sphericity Assumed	2.269	2	1.134	2.488	.095
	Greenhouse-Geisser	2.269	1.954	1.161	2.488	.097
	Huynh-Feldt	2.269	2.000	1.134	2.488	.095
	Lower-bound	2.269	1.000	2.269	2.488	.130
Error(Location*WordValence)	Sphericity Assumed	19.148	42	.456		
	Greenhouse-Geisser	19.148	41.033	.467		
	Huynh-Feldt	19.148	42.000	.456		
	Lower-bound	19.148	21.000	.912		
Site * Location * WordValence	Sphericity Assumed	.109	2	.054	.135	.874
	Greenhouse-Geisser	.109	1.965	.055	.135	.871
	Huynh-Feldt	.109	2.000	.054	.135	.874
	Lower-bound	.109	1.000	.109	.135	.717
Site * Location * WordValence * BloodSugarPre	Sphericity Assumed	.384	2	.192	.475	.625
	Greenhouse-Geisser	.384	1.965	.196	.475	.622
	Huynh-Feldt	.384	2.000	.192	.475	.625
	Lower-bound	.384	1.000	.384	.475	.498
Site * Location *	Sphericity Assumed	.609	2	.305	.753	.477

WordValence * Group	Greenhouse-Geisser	.609	1.965	.310	.753	.475
	Huynh-Feldt	.609	2.000	.305	.753	.477
	Lower-bound	.609	1.000	.609	.753	.395
Error(Site*Location*WordValence)	Sphericity Assumed	16.992	42	.405		
	Greenhouse-Geisser	16.992	41.269	.412		
	Huynh-Feldt	16.992	42.000	.405		
	Lower-bound	16.992	21.000	.809		
Site * PictureType	Sphericity Assumed	9.475	3	3.158	.736	.535
	Greenhouse-Geisser	9.475	2.229	4.251	.736	.498
	Huynh-Feldt	9.475	2.743	3.454	.736	.524
	Lower-bound	9.475	1.000	9.475	.736	.401
Site * PictureType * BloodSugarPre	Sphericity Assumed	13.486	3	4.495	1.047	.378
	Greenhouse-Geisser	13.486	2.229	6.051	1.047	.365
	Huynh-Feldt	13.486	2.743	4.916	1.047	.374
	Lower-bound	13.486	1.000	13.486	1.047	.318
Site * PictureType * Group	Sphericity Assumed	4.457	3	1.486	.346	.792
	Greenhouse-Geisser	4.457	2.229	2.000	.346	.732
	Huynh-Feldt	4.457	2.743	1.625	.346	.774
	Lower-bound	4.457	1.000	4.457	.346	.563
Error(Site*PictureType)	Sphericity Assumed	270.408	63	4.292		
	Greenhouse-Geisser	270.408	46.805	5.777		
	Huynh-Feldt	270.408	57.605	4.694		
	Lower-bound	270.408	21.000	12.877		
Location * PictureType	Sphericity Assumed	6.148	6	1.025	1.256	.283
	Greenhouse-Geisser	6.148	2.681	2.293	1.256	.297
	Huynh-Feldt	6.148	3.403	1.807	1.256	.296
	Lower-bound	6.148	1.000	6.148	1.256	.275
Location * PictureType * BloodSugarPre	Sphericity Assumed	3.767	6	.628	.770	.595
	Greenhouse-Geisser	3.767	2.681	1.405	.770	.503
	Huynh-Feldt	3.767	3.403	1.107	.770	.530
	Lower-bound	3.767	1.000	3.767	.770	.390
Location * PictureType * Group	Sphericity Assumed	.549	6	.091	.112	.995
	Greenhouse-Geisser	.549	2.681	.205	.112	.939
	Huynh-Feldt	.549	3.403	.161	.112	.965
	Lower-bound	.549	1.000	.549	.112	.741
Error(Location*PictureType)	Sphericity Assumed	102.810	126	.816		
	Greenhouse-Geisser	102.810	56.301	1.826		
	Huynh-Feldt	102.810	71.469	1.439		
	Lower-bound	102.810	21.000	4.896		

Site * Location * PictureType	Sphericity Assumed	1.700	6	.283	.577	.748
	Greenhouse-Geisser	1.700	2.089	.814	.577	.573
	Huynh-Feldt	1.700	2.546	.668	.577	.605
	Lower-bound	1.700	1.000	1.700	.577	.456
Site * Location * PictureType * BloodSugarPre	Sphericity Assumed	3.416	6	.569	1.159	.333
	Greenhouse-Geisser	3.416	2.089	1.635	1.159	.325
	Huynh-Feldt	3.416	2.546	1.342	1.159	.330
	Lower-bound	3.416	1.000	3.416	1.159	.294
Site * Location * PictureType * Group	Sphericity Assumed	4.512	6	.752	1.531	.173
	Greenhouse-Geisser	4.512	2.089	2.160	1.531	.227
	Huynh-Feldt	4.512	2.546	1.772	1.531	.222
	Lower-bound	4.512	1.000	4.512	1.531	.230
Error(Site*Location*PictureType)	Sphericity Assumed	61.893	126	.491		
	Greenhouse-Geisser	61.893	43.873	1.411		
	Huynh-Feldt	61.893	53.459	1.158		
	Lower-bound	61.893	21.000	2.947		
WordValence * PictureType	Sphericity Assumed	18.499	3	6.166	.146	.932
	Greenhouse-Geisser	18.499	1.418	13.044	.146	.791
	Huynh-Feldt	18.499	1.636	11.307	.146	.823
	Lower-bound	18.499	1.000	18.499	.146	.706
WordValence * PictureType * BloodSugarPre	Sphericity Assumed	17.982	3	5.994	.142	.934
	Greenhouse-Geisser	17.982	1.418	12.680	.142	.795
	Huynh-Feldt	17.982	1.636	10.991	.142	.827
	Lower-bound	17.982	1.000	17.982	.142	.710
WordValence * PictureType * Group	Sphericity Assumed	132.522	3	44.174	1.046	.379
	Greenhouse-Geisser	132.522	1.418	93.446	1.046	.341
	Huynh-Feldt	132.522	1.636	81.003	1.046	.350
	Lower-bound	132.522	1.000	132.522	1.046	.318
Error(WordValence*PictureType)	Sphericity Assumed	2661.391	63	42.244		
	Greenhouse-Geisser	2661.391	29.782	89.364		
	Huynh-Feldt	2661.391	34.356	77.465		
	Lower-bound	2661.391	21.000	126.733		
Site * WordValence * PictureType	Sphericity Assumed	16.767	3	5.589	1.295	.284
	Greenhouse-Geisser	16.767	2.230	7.517	1.295	.285
	Huynh-Feldt	16.767	2.745	6.107	1.295	.285
	Lower-bound	16.767	1.000	16.767	1.295	.268
Site * WordValence * PictureType * BloodSugarPre	Sphericity Assumed	17.185	3	5.728	1.327	.273
	Greenhouse-Geisser	17.185	2.230	7.704	1.327	.276
	Huynh-Feldt	17.185	2.745	6.259	1.327	.275

	Lower-bound	17.185	1.000	17.185	1.327	.262
Site * WordValence * PictureType * Group	Sphericity Assumed	8.007	3	2.669	.619	.606
	Greenhouse-Geisser	8.007	2.230	3.590	.619	.560
	Huynh-Feldt	8.007	2.745	2.916	.619	.592
	Lower-bound	8.007	1.000	8.007	.619	.440
Error(Site*WordValence*PictureType)	Sphericity Assumed	271.854	63	4.315		
	Greenhouse-Geisser	271.854	46.840	5.804		
	Huynh-Feldt	271.854	57.655	4.715		
	Lower-bound	271.854	21.000	12.945		
Location * WordValence * PictureType	Sphericity Assumed	2.982	6	.497	.635	.702
	Greenhouse-Geisser	2.982	2.210	1.350	.635	.549
	Huynh-Feldt	2.982	2.716	1.098	.635	.580
	Lower-bound	2.982	1.000	2.982	.635	.434
Location * WordValence * PictureType * BloodSugarPre	Sphericity Assumed	2.665	6	.444	.568	.755
	Greenhouse-Geisser	2.665	2.210	1.206	.568	.587
	Huynh-Feldt	2.665	2.716	.981	.568	.622
	Lower-bound	2.665	1.000	2.665	.568	.459
Location * WordValence * PictureType * Group	Sphericity Assumed	2.898	6	.483	.618	.716
	Greenhouse-Geisser	2.898	2.210	1.312	.618	.559
	Huynh-Feldt	2.898	2.716	1.067	.618	.591
	Lower-bound	2.898	1.000	2.898	.618	.441
Error(Location*WordValence*PictureType)	Sphericity Assumed	98.562	126	.782		
	Greenhouse-Geisser	98.562	46.400	2.124		
	Huynh-Feldt	98.562	57.029	1.728		
	Lower-bound	98.562	21.000	4.693		
Site * Location * WordValence * PictureType	Sphericity Assumed	1.581	6	.264	.512	.798
	Greenhouse-Geisser	1.581	2.074	.762	.512	.609
	Huynh-Feldt	1.581	2.525	.626	.512	.645
	Lower-bound	1.581	1.000	1.581	.512	.482
Site * Location * WordValence * PictureType * BloodSugarPre	Sphericity Assumed	2.319	6	.386	.751	.610
	Greenhouse-Geisser	2.319	2.074	1.118	.751	.483
	Huynh-Feldt	2.319	2.525	.918	.751	.506
	Lower-bound	2.319	1.000	2.319	.751	.396
Site * Location * WordValence * PictureType * Group	Sphericity Assumed	5.033	6	.839	1.630	.144
	Greenhouse-Geisser	5.033	2.074	2.426	1.630	.207
	Huynh-Feldt	5.033	2.525	1.993	1.630	.200
	Lower-bound	5.033	1.000	5.033	1.630	.216
Error(Site*Location*WordValence*PictureType)	Sphericity Assumed	64.864	126	.515		
	Greenhouse-Geisser	64.864	43.563	1.489		

	Huynh-Feldt	64.864	53.024	1.223	
	Lower-bound	64.864	21.000	3.089	

a. Computed using alpha = .05

N200 Tests of Between-Subjects Effects

Measure:MEASURE_1

Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter
Intercept	191.116	1	191.116	1.545	.228	.069	1.54
BloodSugarPre	154.747	1	154.747	1.251	.276	.056	1.25
Group	826.867	1	826.867	6.683	.017	.241	6.68
Error	2598.437	21	123.735				

a. Computed using alpha = .05

P300 Repeated Measures ANOVA Mauchly's Test of Sphericity[b]

Measure:MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[a]		
					Greenhouse-Geisser	Huynh-Feldt	L
Site	1.000	.000	0	.	1.000	1.000	
Location	.750	5.745	2	.057	.800	.938	
WordValence	1.000	.000	0	.	1.000	1.000	
PictureType	.107	44.093	5	.000	.456	.524	
Site * Location	.894	2.237	2	.327	.904	1.000	
Site * WordValence	1.000	.000	0	.	1.000	1.000	
Location * WordValence	.655	8.454	2	.015	.744	.863	
Site * Location * WordValence	.930	1.457	2	.483	.934	1.000	
Site * PictureType	.541	12.113	5	.033	.797	.993	
Location * PictureType	.018	75.888	20	.000	.355	.435	
Site * Location * PictureType	.220	28.454	20	.103	.621	.843	
WordValence * PictureType	.790	4.661	5	.459	.870	1.000	
Site * WordValence * PictureType	.176	34.289	5	.000	.505	.587	
Location * WordValence * PictureType	.002	114.135	20	.000	.293	.348	

Site * Location * WordValence * PictureType	.001	127.566	20	.000	.243	.281

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportiona identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tes Subjects Effects table.

b. Design: Intercept + BloodSugarPre + Group

Within Subjects Design: Site + Location + WordValence + PictureType + Site * Location + Site * WordValence + Location * Wor Site * Location * WordValence + Site * PictureType + Location * PictureType + Site * Location * PictureType + WordValence * P Site * WordValence * PictureType + Location * WordValence * PictureType + Site * Location * WordValence * PictureType

P300 Repeated Measures ANOVA Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Site	Sphericity Assumed	42.545	1	42.545	.371	.54
	Greenhouse-Geisser	42.545	1.000	42.545	.371	.54
	Huynh-Feldt	42.545	1.000	42.545	.371	.54
	Lower-bound	42.545	1.000	42.545	.371	.54
Site * BloodSugarPre	Sphericity Assumed	1.861	1	1.861	.016	.90
	Greenhouse-Geisser	1.861	1.000	1.861	.016	.90
	Huynh-Feldt	1.861	1.000	1.861	.016	.90
	Lower-bound	1.861	1.000	1.861	.016	.90
Site * Group	Sphericity Assumed	87.519	1	87.519	.763	.39
	Greenhouse-Geisser	87.519	1.000	87.519	.763	.39
	Huynh-Feldt	87.519	1.000	87.519	.763	.39
	Lower-bound	87.519	1.000	87.519	.763	.39
Error(Site)	Sphericity Assumed	2407.944	21	114.664		
	Greenhouse-Geisser	2407.944	21.000	114.664		
	Huynh-Feldt	2407.944	21.000	114.664		
	Lower-bound	2407.944	21.000	114.664		
Location	Sphericity Assumed	28.477	2	14.239	1.205	.31
	Greenhouse-Geisser	28.477	1.600	17.794	1.205	.30
	Huynh-Feldt	28.477	1.877	15.173	1.205	.30
	Lower-bound	28.477	1.000	28.477	1.205	.28
Location * BloodSugarPre	Sphericity Assumed	13.107	2	6.553	.555	.57
	Greenhouse-Geisser	13.107	1.600	8.189	.555	.54
	Huynh-Feldt	13.107	1.877	6.983	.555	.56

	Lower-bound	13.107	1.000	13.107	.555	.46
Location * Group	Sphericity Assumed	5.649	2	2.824	.239	.78
	Greenhouse-Geisser	5.649	1.600	3.529	.239	.73
	Huynh-Feldt	5.649	1.877	3.010	.239	.77
	Lower-bound	5.649	1.000	5.649	.239	.63
Error(Location)	Sphericity Assumed	496.224	42	11.815		
	Greenhouse-Geisser	496.224	33.609	14.765		
	Huynh-Feldt	496.224	39.413	12.590		
	Lower-bound	496.224	21.000	23.630		
WordValence	Sphericity Assumed	5.128	1	5.128	.508	.48
	Greenhouse-Geisser	5.128	1.000	5.128	.508	.48
	Huynh-Feldt	5.128	1.000	5.128	.508	.48
	Lower-bound	5.128	1.000	5.128	.508	.48
WordValence * BloodSugarPre	Sphericity Assumed	3.901	1	3.901	.386	.54
	Greenhouse-Geisser	3.901	1.000	3.901	.386	.54
	Huynh-Feldt	3.901	1.000	3.901	.386	.54
	Lower-bound	3.901	1.000	3.901	.386	.54
WordValence * Group	Sphericity Assumed	8.563	1	8.563	.848	.36
	Greenhouse-Geisser	8.563	1.000	8.563	.848	.36
	Huynh-Feldt	8.563	1.000	8.563	.848	.36
	Lower-bound	8.563	1.000	8.563	.848	.36
Error(WordValence)	Sphericity Assumed	212.170	21	10.103		
	Greenhouse-Geisser	212.170	21.000	10.103		
	Huynh-Feldt	212.170	21.000	10.103		
	Lower-bound	212.170	21.000	10.103		
PictureType	Sphericity Assumed	19.362	3	6.454	.349	.79
	Greenhouse-Geisser	19.362	1.369	14.140	.349	.62
	Huynh-Feldt	19.362	1.572	12.315	.349	.65
	Lower-bound	19.362	1.000	19.362	.349	.56
PictureType * BloodSugarPre	Sphericity Assumed	3.179	3	1.060	.057	.98
	Greenhouse-Geisser	3.179	1.369	2.322	.057	.88
	Huynh-Feldt	3.179	1.572	2.022	.057	.90
	Lower-bound	3.179	1.000	3.179	.057	.81
PictureType * Group	Sphericity Assumed	11.654	3	3.885	.210	.88
	Greenhouse-Geisser	11.654	1.369	8.511	.210	.72
	Huynh-Feldt	11.654	1.572	7.412	.210	.75
	Lower-bound	11.654	1.000	11.654	.210	.65
Error(PictureType)	Sphericity Assumed	1163.764	63	18.472		
	Greenhouse-Geisser	1163.764	28.756	40.470		

	Huynh-Feldt	1163.764	33.017	35.248		
	Lower-bound	1163.764	21.000	55.417		
Site * Location	Sphericity Assumed	9.166	2	4.583	.897	.41
	Greenhouse-Geisser	9.166	1.809	5.068	.897	.40
	Huynh-Feldt	9.166	2.000	4.583	.897	.41
	Lower-bound	9.166	1.000	9.166	.897	.35
Site * Location * BloodSugarPre	Sphericity Assumed	.250	2	.125	.024	.97
	Greenhouse-Geisser	.250	1.809	.138	.024	.96
	Huynh-Feldt	.250	2.000	.125	.024	.97
	Lower-bound	.250	1.000	.250	.024	.87
Site * Location * Group	Sphericity Assumed	1.032	2	.516	.101	.90
	Greenhouse-Geisser	1.032	1.809	.571	.101	.88
	Huynh-Feldt	1.032	2.000	.516	.101	.90
	Lower-bound	1.032	1.000	1.032	.101	.75
Error(Site*Location)	Sphericity Assumed	214.616	42	5.110		
	Greenhouse-Geisser	214.616	37.981	5.651		
	Huynh-Feldt	214.616	42.000	5.110		
	Lower-bound	214.616	21.000	10.220		
Site * WordValence	Sphericity Assumed	.576	1	.576	.087	.77
	Greenhouse-Geisser	.576	1.000	.576	.087	.77
	Huynh-Feldt	.576	1.000	.576	.087	.77
	Lower-bound	.576	1.000	.576	.087	.77
Site * WordValence * BloodSugarPre	Sphericity Assumed	2.076	1	2.076	.312	.58
	Greenhouse-Geisser	2.076	1.000	2.076	.312	.58
	Huynh-Feldt	2.076	1.000	2.076	.312	.58
	Lower-bound	2.076	1.000	2.076	.312	.58
Site * WordValence * Group	Sphericity Assumed	8.305	1	8.305	1.250	.27
	Greenhouse-Geisser	8.305	1.000	8.305	1.250	.27
	Huynh-Feldt	8.305	1.000	8.305	1.250	.27
	Lower-bound	8.305	1.000	8.305	1.250	.27
Error(Site*WordValence)	Sphericity Assumed	139.532	21	6.644		
	Greenhouse-Geisser	139.532	21.000	6.644		
	Huynh-Feldt	139.532	21.000	6.644		
	Lower-bound	139.532	21.000	6.644		
Location * WordValence	Sphericity Assumed	.368	2	.184	.159	.85
	Greenhouse-Geisser	.368	1.487	.247	.159	.79
	Huynh-Feldt	.368	1.727	.213	.159	.82
	Lower-bound	.368	1.000	.368	.159	.69
Location * WordValence *	Sphericity Assumed	.024	2	.012	.010	.99

BloodSugarPre	Greenhouse-Geisser	.024	1.487	.016	.010	.97
	Huynh-Feldt	.024	1.727	.014	.010	.98
	Lower-bound	.024	1.000	.024	.010	.92
Location * WordValence * Group	Sphericity Assumed	.904	2	.452	.390	.68
	Greenhouse-Geisser	.904	1.487	.608	.390	.61
	Huynh-Feldt	.904	1.727	.523	.390	.65
	Lower-bound	.904	1.000	.904	.390	.53
Error(Location*WordValence)	Sphericity Assumed	48.719	42	1.160		
	Greenhouse-Geisser	48.719	31.233	1.560		
	Huynh-Feldt	48.719	36.264	1.343		
	Lower-bound	48.719	21.000	2.320		
Site * Location * WordValence	Sphericity Assumed	.163	2	.081	.119	.88
	Greenhouse-Geisser	.163	1.869	.087	.119	.87
	Huynh-Feldt	.163	2.000	.081	.119	.88
	Lower-bound	.163	1.000	.163	.119	.73
Site * Location * WordValence * BloodSugarPre	Sphericity Assumed	.031	2	.016	.023	.97
	Greenhouse-Geisser	.031	1.869	.017	.023	.97
	Huynh-Feldt	.031	2.000	.016	.023	.97
	Lower-bound	.031	1.000	.031	.023	.88
Site * Location * WordValence * Group	Sphericity Assumed	.480	2	.240	.352	.70
	Greenhouse-Geisser	.480	1.869	.257	.352	.69
	Huynh-Feldt	.480	2.000	.240	.352	.70
	Lower-bound	.480	1.000	.480	.352	.55
Error(Site*Location*WordValence)	Sphericity Assumed	28.578	42	.680		
	Greenhouse-Geisser	28.578	39.242	.728		
	Huynh-Feldt	28.578	42.000	.680		
	Lower-bound	28.578	21.000	1.361		
Site * PictureType	Sphericity Assumed	24.032	3	8.011	.950	.42
	Greenhouse-Geisser	24.032	2.392	10.047	.950	.40
	Huynh-Feldt	24.032	2.978	8.071	.950	.42
	Lower-bound	24.032	1.000	24.032	.950	.34
Site * PictureType * BloodSugarPre	Sphericity Assumed	14.956	3	4.985	.591	.62
	Greenhouse-Geisser	14.956	2.392	6.252	.591	.58
	Huynh-Feldt	14.956	2.978	5.023	.591	.62
	Lower-bound	14.956	1.000	14.956	.591	.45
Site * PictureType * Group	Sphericity Assumed	8.110	3	2.703	.321	.81
	Greenhouse-Geisser	8.110	2.392	3.390	.321	.76
	Huynh-Feldt	8.110	2.978	2.724	.321	.80
	Lower-bound	8.110	1.000	8.110	.321	.57

Error(Site*PictureType)	Sphericity Assumed	531.341	63	8.434		
	Greenhouse-Geisser	531.341	50.231	10.578		
	Huynh-Feldt	531.341	62.529	8.498		
	Lower-bound	531.341	21.000	25.302		
Location * PictureType	Sphericity Assumed	3.371	6	.562	.375	.89
	Greenhouse-Geisser	3.371	2.133	1.580	.375	.70
	Huynh-Feldt	3.371	2.607	1.293	.375	.74
	Lower-bound	3.371	1.000	3.371	.375	.54
Location * PictureType * BloodSugarPre	Sphericity Assumed	2.732	6	.455	.304	.93
	Greenhouse-Geisser	2.732	2.133	1.281	.304	.75
	Huynh-Feldt	2.732	2.607	1.048	.304	.79
	Lower-bound	2.732	1.000	2.732	.304	.58
Location * PictureType * Group	Sphericity Assumed	6.195	6	1.033	.690	.65
	Greenhouse-Geisser	6.195	2.133	2.905	.690	.51
	Huynh-Feldt	6.195	2.607	2.376	.690	.54
	Lower-bound	6.195	1.000	6.195	.690	.41
Error(Location*PictureType)	Sphericity Assumed	188.515	126	1.496		
	Greenhouse-Geisser	188.515	44.793	4.209		
	Huynh-Feldt	188.515	54.753	3.443		
	Lower-bound	188.515	21.000	8.977		
Site * Location * PictureType	Sphericity Assumed	.680	6	.113	.226	.96
	Greenhouse-Geisser	.680	3.726	.182	.226	.91
	Huynh-Feldt	.680	5.061	.134	.226	.95
	Lower-bound	.680	1.000	.680	.226	.63
Site * Location * PictureType * BloodSugarPre	Sphericity Assumed	.610	6	.102	.203	.97
	Greenhouse-Geisser	.610	3.726	.164	.203	.92
	Huynh-Feldt	.610	5.061	.121	.203	.96
	Lower-bound	.610	1.000	.610	.203	.65
Site * Location * PictureType * Group	Sphericity Assumed	3.269	6	.545	1.088	.37
	Greenhouse-Geisser	3.269	3.726	.877	1.088	.36
	Huynh-Feldt	3.269	5.061	.646	1.088	.37
	Lower-bound	3.269	1.000	3.269	1.088	.30
Error(Site*Location*PictureType)	Sphericity Assumed	63.087	126	.501		
	Greenhouse-Geisser	63.087	78.246	.806		
	Huynh-Feldt	63.087	106.281	.594		
	Lower-bound	63.087	21.000	3.004		
WordValence * PictureType	Sphericity Assumed	.308	3	.103	.012	.99
	Greenhouse-Geisser	.308	2.609	.118	.012	.99
	Huynh-Feldt	.308	3.000	.103	.012	.99

	Lower-bound	.308	1.000	.308	.012	.91
WordValence * PictureType * BloodSugarPre	Sphericity Assumed	.617	3	.206	.024	.99
	Greenhouse-Geisser	.617	2.609	.236	.024	.99
	Huynh-Feldt	.617	3.000	.206	.024	.99
	Lower-bound	.617	1.000	.617	.024	.87
WordValence * PictureType * Group	Sphericity Assumed	43.204	3	14.401	1.664	.18
	Greenhouse-Geisser	43.204	2.609	16.562	1.664	.19
	Huynh-Feldt	43.204	3.000	14.401	1.664	.18
	Lower-bound	43.204	1.000	43.204	1.664	.21
Error(WordValence*PictureType)	Sphericity Assumed	545.303	63	8.656		
	Greenhouse-Geisser	545.303	54.780	9.954		
	Huynh-Feldt	545.303	63.000	8.656		
	Lower-bound	545.303	21.000	25.967		
Site * WordValence * PictureType	Sphericity Assumed	5.457	3	1.819	.096	.96
	Greenhouse-Geisser	5.457	1.514	3.604	.096	.85
	Huynh-Feldt	5.457	1.762	3.096	.096	.88
	Lower-bound	5.457	1.000	5.457	.096	.76
Site * WordValence * PictureType * BloodSugarPre	Sphericity Assumed	19.068	3	6.356	.336	.79
	Greenhouse-Geisser	19.068	1.514	12.592	.336	.65
	Huynh-Feldt	19.068	1.762	10.819	.336	.69
	Lower-bound	19.068	1.000	19.068	.336	.56
Site * WordValence * PictureType * Group	Sphericity Assumed	88.527	3	29.509	1.560	.20
	Greenhouse-Geisser	88.527	1.514	58.460	1.560	.22
	Huynh-Feldt	88.527	1.762	50.228	1.560	.22
	Lower-bound	88.527	1.000	88.527	1.560	.22
Error(Site*WordValence*PictureType)	Sphericity Assumed	1191.605	63	18.914		
	Greenhouse-Geisser	1191.605	31.800	37.471		
	Huynh-Feldt	1191.605	37.012	32.195		
	Lower-bound	1191.605	21.000	56.743		
Location * WordValence * PictureType	Sphericity Assumed	1.933	6	.322	.196	.97
	Greenhouse-Geisser	1.933	1.756	1.101	.196	.79
	Huynh-Feldt	1.933	2.087	.927	.196	.83
	Lower-bound	1.933	1.000	1.933	.196	.66
Location * WordValence * PictureType * BloodSugarPre	Sphericity Assumed	2.210	6	.368	.224	.96
	Greenhouse-Geisser	2.210	1.756	1.258	.224	.77
	Huynh-Feldt	2.210	2.087	1.059	.224	.80
	Lower-bound	2.210	1.000	2.210	.224	.64
Location * WordValence * PictureType * Group	Sphericity Assumed	6.751	6	1.125	.684	.66
	Greenhouse-Geisser	6.751	1.756	3.844	.684	.49

	Huynh-Feldt	6.751	2.087	3.235	.684	.51
	Lower-bound	6.751	1.000	6.751	.684	.41
Error(Location*WordValence *PictureType)	Sphericity Assumed	207.406	126	1.646		
	Greenhouse-Geisser	207.406	36.884	5.623		
	Huynh-Feldt	207.406	43.818	4.733		
	Lower-bound	207.406	21.000	9.876		
Site * Location * WordValence * PictureType	Sphericity Assumed	4.429	6	.738	.464	.83
	Greenhouse-Geisser	4.429	1.457	3.040	.464	.57
	Huynh-Feldt	4.429	1.687	2.626	.464	.60
	Lower-bound	4.429	1.000	4.429	.464	.50
Site * Location * WordValence * PictureType * BloodSugarPre	Sphericity Assumed	6.377	6	1.063	.669	.67
	Greenhouse-Geisser	6.377	1.457	4.378	.669	.47
	Huynh-Feldt	6.377	1.687	3.781	.669	.49
	Lower-bound	6.377	1.000	6.377	.669	.42
Site * Location * WordValence * PictureType * Group	Sphericity Assumed	10.894	6	1.816	1.142	.34
	Greenhouse-Geisser	10.894	1.457	7.479	1.142	.31
	Huynh-Feldt	10.894	1.687	6.460	1.142	.32
	Lower-bound	10.894	1.000	10.894	1.142	.29
Error(Site*Location*WordValence*PictureType)	Sphericity Assumed	200.306	126	1.590		
	Greenhouse-Geisser	200.306	30.590	6.548		
	Huynh-Feldt	200.306	35.417	5.656		
	Lower-bound	200.306	21.000	9.538		

P300 Tests of Between-Subjects Effects

Measure:MEASURE_1

Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	172.982	1	172.982	2.569	.124	.109
BloodSugarPre	2.339	1	2.339	.035	.854	.002
Group	171.288	1	171.288	2.544	.126	.108
Error	1413.867	21	67.327			

LPP Repeated Measures ANOVA Mauchly's Test of Sphericity[b]

Measure:MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[a] Greenhouse-Geisser	Huynh-Feldt	L
Site	1.000	.000	0	.	1.000	1.000	
Location	.659	8.338	2	.015	.746	.866	
WordValence	1.000	.000	0	.	1.000	1.000	
PictureTYpe	.372	19.486	5	.002	.629	.755	
Site * Location	.745	5.896	2	.052	.797	.934	
Site * WordValence	1.000	.000	0	.	1.000	1.000	
Location * WordValence	.749	5.780	2	.056	.799	.937	
Site * Location * WordValence	.848	3.295	2	.193	.868	1.000	
Site * PictureTYpe	.467	15.004	5	.010	.756	.933	
Location * PictureTYpe	.003	111.015	20	.000	.301	.359	
Site * Location * PictureTYpe	.156	34.927	20	.022	.631	.860	
WordValence * PictureTYpe	.196	32.166	5	.000	.512	.597	
Site * WordValence * PictureTYpe	.315	22.753	5	.000	.564	.666	
Location * WordValence * PictureTYpe	.004	105.162	20	.000	.289	.342	
Site * Location * WordValence * PictureTYpe	.003	108.955	20	.000	.299	.356	

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportiona identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tes Subjects Effects table.

b. Design: Intercept + BloodSugarPre + Group

Within Subjects Design: Site + Location + WordValence + PictureTYpe + Site * Location + Site * WordValence + Location * Wo Site * Location * WordValence + Site * PictureTYpe + Location * PictureTYpe + Site * Location * PictureTYpe + WordValence * + Site * WordValence * PictureTYpe + Location * WordValence * PictureTYpe + Site * Location * WordValence * PictureTYpe

LPP Repeated Measures ANOVA Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Site	Sphericity Assumed	9.172	1	9.172	.074	.78
	Greenhouse-Geisser	9.172	1.000	9.172	.074	.78
	Huynh-Feldt	9.172	1.000	9.172	.074	.78
	Lower-bound	9.172	1.000	9.172	.074	.78

Site * BloodSugarPre	Sphericity Assumed	591.419	1	591.419	4.747	.04
	Greenhouse-Geisser	591.419	1.000	591.419	4.747	.04
	Huynh-Feldt	591.419	1.000	591.419	4.747	.04
	Lower-bound	591.419	1.000	591.419	4.747	.04
Site * Group	Sphericity Assumed	283.777	1	283.777	2.278	.14
	Greenhouse-Geisser	283.777	1.000	283.777	2.278	.14
	Huynh-Feldt	283.777	1.000	283.777	2.278	.14
	Lower-bound	283.777	1.000	283.777	2.278	.14
Error(Site)	Sphericity Assumed	2616.581	21	124.599		
	Greenhouse-Geisser	2616.581	21.000	124.599		
	Huynh-Feldt	2616.581	21.000	124.599		
	Lower-bound	2616.581	21.000	124.599		
Location	Sphericity Assumed	16.631	2	8.315	.457	.63
	Greenhouse-Geisser	16.631	1.492	11.150	.457	.58
	Huynh-Feldt	16.631	1.732	9.600	.457	.60
	Lower-bound	16.631	1.000	16.631	.457	.50
Location * BloodSugarPre	Sphericity Assumed	.077	2	.039	.002	.99
	Greenhouse-Geisser	.077	1.492	.052	.002	.99
	Huynh-Feldt	.077	1.732	.045	.002	.99
	Lower-bound	.077	1.000	.077	.002	.96
Location * Group	Sphericity Assumed	20.460	2	10.230	.563	.57
	Greenhouse-Geisser	20.460	1.492	13.717	.563	.52
	Huynh-Feldt	20.460	1.732	11.810	.563	.55
	Lower-bound	20.460	1.000	20.460	.563	.46
Error(Location)	Sphericity Assumed	763.676	42	18.183		
	Greenhouse-Geisser	763.676	31.322	24.382		
	Huynh-Feldt	763.676	36.380	20.992		
	Lower-bound	763.676	21.000	36.366		
WordValence	Sphericity Assumed	3.087	1	3.087	.153	.70
	Greenhouse-Geisser	3.087	1.000	3.087	.153	.70
	Huynh-Feldt	3.087	1.000	3.087	.153	.70
	Lower-bound	3.087	1.000	3.087	.153	.70
WordValence * BloodSugarPre	Sphericity Assumed	.708	1	.708	.035	.85
	Greenhouse-Geisser	.708	1.000	.708	.035	.85
	Huynh-Feldt	.708	1.000	.708	.035	.85
	Lower-bound	.708	1.000	.708	.035	.85
WordValence * Group	Sphericity Assumed	8.232	1	8.232	.408	.53
	Greenhouse-Geisser	8.232	1.000	8.232	.408	.53
	Huynh-Feldt	8.232	1.000	8.232	.408	.53

	Lower-bound	8.232	1.000	8.232	.408	.53
Error(WordValence)	Sphericity Assumed	423.825	21	20.182		
	Greenhouse-Geisser	423.825	21.000	20.182		
	Huynh-Feldt	423.825	21.000	20.182		
	Lower-bound	423.825	21.000	20.182		
PictureTYpe	Sphericity Assumed	1.762	3	.587	.039	.99
	Greenhouse-Geisser	1.762	1.887	.934	.039	.95
	Huynh-Feldt	1.762	2.266	.778	.039	.97
	Lower-bound	1.762	1.000	1.762	.039	.84
PictureTYpe * BloodSugarPre	Sphericity Assumed	5.416	3	1.805	.118	.94
	Greenhouse-Geisser	5.416	1.887	2.869	.118	.87
	Huynh-Feldt	5.416	2.266	2.391	.118	.91
	Lower-bound	5.416	1.000	5.416	.118	.73
PictureTYpe * Group	Sphericity Assumed	21.654	3	7.218	.473	.70
	Greenhouse-Geisser	21.654	1.887	11.472	.473	.61
	Huynh-Feldt	21.654	2.266	9.558	.473	.65
	Lower-bound	21.654	1.000	21.654	.473	.49
Error(PictureTYpe)	Sphericity Assumed	960.833	63	15.251		
	Greenhouse-Geisser	960.833	39.637	24.241		
	Huynh-Feldt	960.833	47.576	20.196		
	Lower-bound	960.833	21.000	45.754		
Site * Location	Sphericity Assumed	8.960	2	4.480	.719	.49
	Greenhouse-Geisser	8.960	1.593	5.624	.719	.46
	Huynh-Feldt	8.960	1.867	4.799	.719	.48
	Lower-bound	8.960	1.000	8.960	.719	.40
Site * Location * BloodSugarPre	Sphericity Assumed	13.623	2	6.811	1.093	.34
	Greenhouse-Geisser	13.623	1.593	8.550	1.093	.33
	Huynh-Feldt	13.623	1.867	7.296	1.093	.34
	Lower-bound	13.623	1.000	13.623	1.093	.30
Site * Location * Group	Sphericity Assumed	23.626	2	11.813	1.896	.16
	Greenhouse-Geisser	23.626	1.593	14.829	1.896	.17
	Huynh-Feldt	23.626	1.867	12.653	1.896	.16
	Lower-bound	23.626	1.000	23.626	1.896	.18
Error(Site*Location)	Sphericity Assumed	261.677	42	6.230		
	Greenhouse-Geisser	261.677	33.458	7.821		
	Huynh-Feldt	261.677	39.212	6.673		
	Lower-bound	261.677	21.000	12.461		
Site * WordValence	Sphericity Assumed	2.580	1	2.580	.196	.66
	Greenhouse-Geisser	2.580	1.000	2.580	.196	.66

	Huynh-Feldt	2.580	1.000	2.580	.196	.66
	Lower-bound	2.580	1.000	2.580	.196	.66
Site * WordValence * BloodSugarPre	Sphericity Assumed	.245	1	.245	.019	.89
	Greenhouse-Geisser	.245	1.000	.245	.019	.89
	Huynh-Feldt	.245	1.000	.245	.019	.89
	Lower-bound	.245	1.000	.245	.019	.89
Site * WordValence * Group	Sphericity Assumed	7.997	1	7.997	.608	.44
	Greenhouse-Geisser	7.997	1.000	7.997	.608	.44
	Huynh-Feldt	7.997	1.000	7.997	.608	.44
	Lower-bound	7.997	1.000	7.997	.608	.44
Error(Site*WordValence)	Sphericity Assumed	276.227	21	13.154		
	Greenhouse-Geisser	276.227	21.000	13.154		
	Huynh-Feldt	276.227	21.000	13.154		
	Lower-bound	276.227	21.000	13.154		
Location * WordValence	Sphericity Assumed	1.411	2	.705	.804	.45
	Greenhouse-Geisser	1.411	1.599	.882	.804	.43
	Huynh-Feldt	1.411	1.875	.753	.804	.44
	Lower-bound	1.411	1.000	1.411	.804	.38
Location * WordValence * BloodSugarPre	Sphericity Assumed	.522	2	.261	.298	.74
	Greenhouse-Geisser	.522	1.599	.327	.298	.69
	Huynh-Feldt	.522	1.875	.278	.298	.73
	Lower-bound	.522	1.000	.522	.298	.59
Location * WordValence * Group	Sphericity Assumed	.138	2	.069	.079	.92
	Greenhouse-Geisser	.138	1.599	.087	.079	.88
	Huynh-Feldt	.138	1.875	.074	.079	.91
	Lower-bound	.138	1.000	.138	.079	.78
Error(Location*WordValence)	Sphericity Assumed	36.838	42	.877		
	Greenhouse-Geisser	36.838	33.574	1.097		
	Huynh-Feldt	36.838	39.367	.936		
	Lower-bound	36.838	21.000	1.754		
Site * Location * WordValence	Sphericity Assumed	2.563	2	1.282	.630	.53
	Greenhouse-Geisser	2.563	1.736	1.476	.630	.51
	Huynh-Feldt	2.563	2.000	1.282	.630	.53
	Lower-bound	2.563	1.000	2.563	.630	.43
Site * Location * WordValence * BloodSugarPre	Sphericity Assumed	2.398	2	1.199	.589	.55
	Greenhouse-Geisser	2.398	1.736	1.381	.589	.53
	Huynh-Feldt	2.398	2.000	1.199	.589	.55
	Lower-bound	2.398	1.000	2.398	.589	.45
Site * Location *	Sphericity Assumed	.014	2	.007	.004	.99

WordValence * Group	Greenhouse-Geisser	.014	1.736	.008	.004	.99
	Huynh-Feldt	.014	2.000	.007	.004	.99
	Lower-bound	.014	1.000	.014	.004	.95
Error(Site*Location*WordValence)	Sphericity Assumed	85.504	42	2.036		
	Greenhouse-Geisser	85.504	36.461	2.345		
	Huynh-Feldt	85.504	42.000	2.036		
	Lower-bound	85.504	21.000	4.072		
Site * PictureTYpe	Sphericity Assumed	16.740	3	5.580	.296	.82
	Greenhouse-Geisser	16.740	2.267	7.384	.296	.77
	Huynh-Feldt	16.740	2.798	5.984	.296	.81
	Lower-bound	16.740	1.000	16.740	.296	.59
Site * PictureTYpe * BloodSugarPre	Sphericity Assumed	5.768	3	1.923	.102	.95
	Greenhouse-Geisser	5.768	2.267	2.544	.102	.92
	Huynh-Feldt	5.768	2.798	2.062	.102	.95
	Lower-bound	5.768	1.000	5.768	.102	.75
Site * PictureTYpe * Group	Sphericity Assumed	49.338	3	16.446	.874	.46
	Greenhouse-Geisser	49.338	2.267	21.763	.874	.43
	Huynh-Feldt	49.338	2.798	17.635	.874	.45
	Lower-bound	49.338	1.000	49.338	.874	.36
Error(Site*PictureTYpe)	Sphericity Assumed	1185.887	63	18.824		
	Greenhouse-Geisser	1185.887	47.608	24.909		
	Huynh-Feldt	1185.887	58.752	20.185		
	Lower-bound	1185.887	21.000	56.471		
Location * PictureTYpe	Sphericity Assumed	1.703	6	.284	.181	.98
	Greenhouse-Geisser	1.703	1.804	.944	.181	.81
	Huynh-Feldt	1.703	2.152	.791	.181	.85
	Lower-bound	1.703	1.000	1.703	.181	.67
Location * PictureTYpe * BloodSugarPre	Sphericity Assumed	1.335	6	.222	.142	.99
	Greenhouse-Geisser	1.335	1.804	.740	.142	.84
	Huynh-Feldt	1.335	2.152	.620	.142	.88
	Lower-bound	1.335	1.000	1.335	.142	.71
Location * PictureTYpe * Group	Sphericity Assumed	3.675	6	.612	.391	.88
	Greenhouse-Geisser	3.675	1.804	2.036	.391	.65
	Huynh-Feldt	3.675	2.152	1.708	.391	.69
	Lower-bound	3.675	1.000	3.675	.391	.53
Error(Location*PictureTYpe)	Sphericity Assumed	197.225	126	1.565		
	Greenhouse-Geisser	197.225	37.891	5.205		
	Huynh-Feldt	197.225	45.187	4.365		
	Lower-bound	197.225	21.000	9.392		

Site * Location * PictureTYpe	Sphericity Assumed	1.044	6	.174	.290	.94
	Greenhouse-Geisser	1.044	3.786	.276	.290	.87
	Huynh-Feldt	1.044	5.162	.202	.290	.92
	Lower-bound	1.044	1.000	1.044	.290	.59
Site * Location * PictureTYpe * BloodSugarPre	Sphericity Assumed	.885	6	.148	.246	.96
	Greenhouse-Geisser	.885	3.786	.234	.246	.90
	Huynh-Feldt	.885	5.162	.172	.246	.94
	Lower-bound	.885	1.000	.885	.246	.62
Site * Location * PictureTYpe * Group	Sphericity Assumed	6.164	6	1.027	1.713	.12
	Greenhouse-Geisser	6.164	3.786	1.628	1.713	.15
	Huynh-Feldt	6.164	5.162	1.194	1.713	.13
	Lower-bound	6.164	1.000	6.164	1.713	.20
Error(Site*Location*PictureTYpe)	Sphericity Assumed	75.584	126	.600		
	Greenhouse-Geisser	75.584	79.505	.951		
	Huynh-Feldt	75.584	108.407	.697		
	Lower-bound	75.584	21.000	3.599		
WordValence * PictureTYpe	Sphericity Assumed	9.710	3	3.237	.132	.94
	Greenhouse-Geisser	9.710	1.537	6.318	.132	.82
	Huynh-Feldt	9.710	1.792	5.417	.132	.85
	Lower-bound	9.710	1.000	9.710	.132	.72
WordValence * PictureTYpe * BloodSugarPre	Sphericity Assumed	7.201	3	2.400	.098	.96
	Greenhouse-Geisser	7.201	1.537	4.685	.098	.85
	Huynh-Feldt	7.201	1.792	4.017	.098	.88
	Lower-bound	7.201	1.000	7.201	.098	.75
WordValence * PictureTYpe * Group	Sphericity Assumed	128.282	3	42.761	1.745	.16
	Greenhouse-Geisser	128.282	1.537	83.470	1.745	.19
	Huynh-Feldt	128.282	1.792	71.572	1.745	.19
	Lower-bound	128.282	1.000	128.282	1.745	.20
Error(WordValence*PictureTYpe)	Sphericity Assumed	1543.627	63	24.502		
	Greenhouse-Geisser	1543.627	32.274	47.829		
	Huynh-Feldt	1543.627	37.639	41.011		
	Lower-bound	1543.627	21.000	73.506		
Site * WordValence * PictureTYpe	Sphericity Assumed	8.343	3	2.781	.182	.90
	Greenhouse-Geisser	8.343	1.692	4.932	.182	.79
	Huynh-Feldt	8.343	1.999	4.173	.182	.83
	Lower-bound	8.343	1.000	8.343	.182	.67
Site * WordValence * PictureTYpe * BloodSugarPre	Sphericity Assumed	20.461	3	6.820	.445	.72
	Greenhouse-Geisser	20.461	1.692	12.095	.445	.61
	Huynh-Feldt	20.461	1.999	10.235	.445	.64

	Lower-bound	20.461	1.000	20.461	.445	.51
Site * WordValence * PictureTYpe * Group	Sphericity Assumed	56.385	3	18.795	1.227	.30
	Greenhouse-Geisser	56.385	1.692	33.332	1.227	.30
	Huynh-Feldt	56.385	1.999	28.206	1.227	.30
	Lower-bound	56.385	1.000	56.385	1.227	.28
Error(Site*WordValence*PictureTYpe)	Sphericity Assumed	965.045	63	15.318		
	Greenhouse-Geisser	965.045	35.524	27.166		
	Huynh-Feldt	965.045	41.980	22.988		
	Lower-bound	965.045	21.000	45.955		
Location * WordValence * PictureTYpe	Sphericity Assumed	.632	6	.105	.079	.99
	Greenhouse-Geisser	.632	1.733	.364	.079	.90
	Huynh-Feldt	.632	2.055	.307	.079	.92
	Lower-bound	.632	1.000	.632	.079	.78
Location * WordValence * PictureTYpe * BloodSugarPre	Sphericity Assumed	2.968	6	.495	.372	.89
	Greenhouse-Geisser	2.968	1.733	1.713	.372	.66
	Huynh-Feldt	2.968	2.055	1.445	.372	.69
	Lower-bound	2.968	1.000	2.968	.372	.54
Location * WordValence * PictureTYpe * Group	Sphericity Assumed	16.379	6	2.730	2.054	.06
	Greenhouse-Geisser	16.379	1.733	9.452	2.054	.14
	Huynh-Feldt	16.379	2.055	7.971	2.054	.13
	Lower-bound	16.379	1.000	16.379	2.054	.16
Error(Location*WordValence*PictureTYpe)	Sphericity Assumed	167.482	126	1.329		
	Greenhouse-Geisser	167.482	36.390	4.602		
	Huynh-Feldt	167.482	43.149	3.881		
	Lower-bound	167.482	21.000	7.975		
Site * Location * WordValence * PictureTYpe	Sphericity Assumed	2.924	6	.487	.351	.90
	Greenhouse-Geisser	2.924	1.792	1.632	.351	.68
	Huynh-Feldt	2.924	2.135	1.370	.351	.72
	Lower-bound	2.924	1.000	2.924	.351	.56
Site * Location * WordValence * PictureTYpe * BloodSugarPre	Sphericity Assumed	.866	6	.144	.104	.99
	Greenhouse-Geisser	.866	1.792	.483	.104	.88
	Huynh-Feldt	.866	2.135	.406	.104	.91
	Lower-bound	.866	1.000	.866	.104	.75
Site * Location * WordValence * PictureTYpe * Group	Sphericity Assumed	9.975	6	1.662	1.196	.31
	Greenhouse-Geisser	9.975	1.792	5.567	1.196	.31
	Huynh-Feldt	9.975	2.135	4.673	1.196	.31
	Lower-bound	9.975	1.000	9.975	1.196	.28
Error(Site*Location*WordValence*PictureTYpe)	Sphericity Assumed	175.077	126	1.390		
	Greenhouse-Geisser	175.077	37.629	4.653		

	Huynh-Feldt	175.077	44.830	3.905	
	Lower-bound	175.077	21.000	8.337	

LPP Tests of Between-Subjects Effects

Measure:MEASURE_1

Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	173.145	1	173.145	.938	.344	.043
BloodSugarPre	161.486	1	161.486	.875	.360	.040
Group	128.319	1	128.319	.695	.414	.032
Error	3875.529	21	184.549			